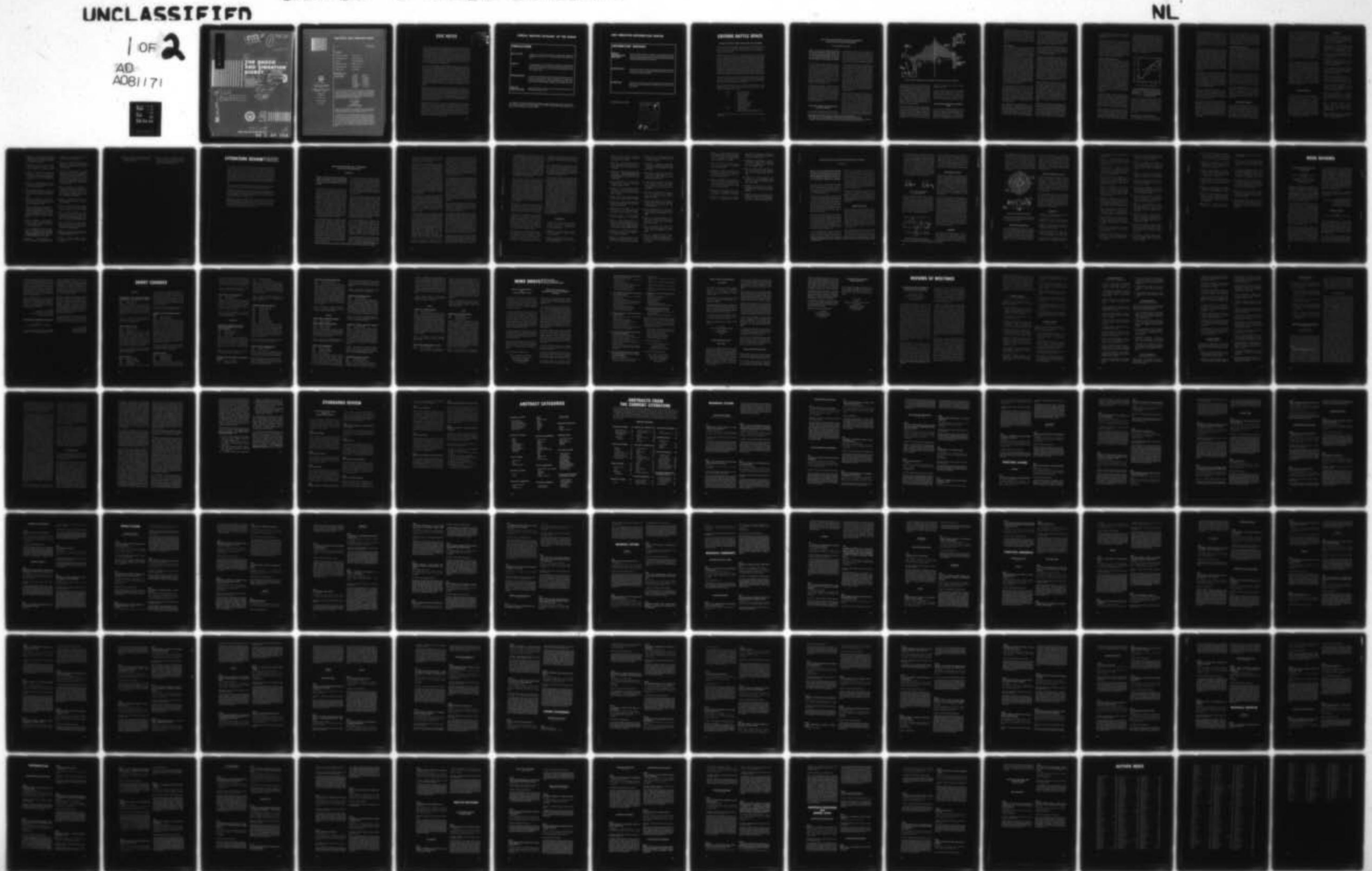
AD-A081 171 NAVAL RESEARCH LAB WASHINGTON DC SHOCK AND VIBRATION--ETC F/G 20/11
THE SHOCK AND VIBRATION DIGEST. VOLUME 12, NUMBER 1,(U)
JAN 80 J NAGLE-ESHLEMAN

UNCLASSIFIED NL

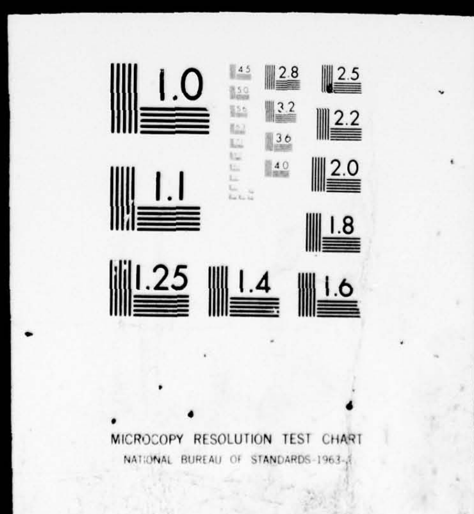
1 OF 2
AD
A081171



CLASSIF

1 OF 2

AD
A081171



LEVEL #II

VOLUME 12, NO. 1
JANUARY 1980

(1)
B.S.

#2 A081303

AD A081171

(6)

THE SHOCK AND VIBRATION DIGEST.

Volume 12,
Number 1,

A PUBLICATION OF
THE SHOCK AND VIBRATION
INFORMATION CENTER
NAVAL RESEARCH LABORATORY
WASHINGTON, D.C.

DTIC
ELECTE
FEB 2 8 1980
S D
C

(11) Jan 80

(10) Judith
/Nagle-Eshleman

(12) 108

DDC FILE COPY

OFFICE OF
THE UNDER
SECRETARY
OF DEFENSE
FOR RESEARCH
AND
ENGINEERING

389004

~~Approved for public release; distribution unlimited.~~

80 2 26 064

THE SHOCK AND VIBRATION DIGEST

Volume 12 No. 1
January 1980

STAFF

EDITORIAL ADVISOR:	Henry C. Pusey
TECHNICAL EDITOR:	Ronald L. Eshleman
EDITOR:	Judith Nagle-Eshleman
RESEARCH EDITOR:	Milda Z. Tamulionis
ASSISTANT EDITOR:	Martha N. Moss
PRODUCTION:	Gwen Wassilak

BOARD OF EDITORS

R. Belsheim
R.L. Bort
J.D.C. Crisp
C.L. Dym
D.J. Johns
G.H. Klein
K.E. McKee
J.A. Macinante
C.T. Morrow
J.T. Oden
W.D. Pilkey
E. Sevin
J.G. Showalter
R.A. Skop
C.B. Smith
J.C. Snowdon
R.H. Volin
H. von Gierke
E.E. Ungar

A publication of

THE SHOCK AND VIBRATION
INFORMATION CENTER

Code 5804, Naval Research Laboratory
Washington, D.C. 20375

Henry C. Pusey
Director

Rudolph H. Volin

J. Gordan Showalter

Carol Healey

The Shock and Vibration Digest is a monthly publication of the Shock and Vibration Information Center. The goal of the Digest is to provide efficient transfer of sound, shock, and vibration technology among researchers and practicing engineers. Subjective and objective analyses of the literature are provided along with news and editorial material. News items and articles to be considered for publication should be submitted to:

Dr. R.L. Eshleman
Vibration Institute
Suite 206
101 West 55th Street
Clarendon Hills, Illinois 60514

Copies of articles abstracted are not available from the Shock and Vibration Information Center (except for those generated by SVIC). Inquiries should be directed to library resources, authors, or the original publishers.

This periodical is for sale on subscription at an annual rate of $100.00. For foreign subscribers, there is an additional 25 percent charge for overseas delivery on both regular subscriptions and back issues. Subscriptions are accepted for the calendar year, beginning with the January issue. Back issues are available by volume (12 issues) for $15.00. Orders may be forwarded at any time, in any form, to SVIC, Code 5804, Naval Research Laboratory, Washington, D.C. 20375. Issuance of this periodical is approved in accordance with the Department of the Navy Publications and Printing Regulations, NAVEXOS P-35.

DTIC
ELECTE
FEB 2 8 1980
S D
C

SVIC NOTES

As we enter our twelfth year of publication I have been reflecting on how the DIGEST has changed, principally because of the technical information needs of the readers as we perceive them. As an information analysis center, SVIC has a mission to be the central source for technical information in our field. The emphasis is on timeliness and usefulness of this information. On a day-to-day basis, as we respond to information queries, we attempt to screen, sift and analyze potentially relevant information so that we can provide the user with that information most pertinent to the problem at hand. The idea is that SVIC acts as an extension of the staff of research and development organizations, allowing scientists and engineers more time to concentrate on their primary objectives.

In my opinion, the DIGEST is another important mechanism used to achieve our goals. It is a "current awareness" vehicle. Here we must anticipate the information requirements of a broad technical community. We try to develop an understanding of the best ways to present information to the reader so that it will be useful and, without a great amount of searching, directly applicable to his problems. To be sure we have some feedback, mostly favorable, as to the kind of job we are doing. In my opinion this is not enough, since the contents and format of this publication are still largely based upon our perception of what the readers want. Perhaps our views are not correct. There may be some areas in which we fall short of the mark. As I have said before, this DIGEST is for you. I think your opinions about it should be heard. Your suggestions for improvements should be implemented wherever possible.

With these things in mind, I ask that you write to me at SVIC. Let me have the benefit of your opinion. Tell me about the weaknesses and the strengths in this publication. I want to know about your information needs as an individual. Collectively, these individual inputs will allow us to appraise the needs of our broad technical community and will assist us in making our plans for the future on an intelligent basis. With your permission, I will publish selected letters that may be useful to other readers. My hope is that we will have so many letters that we will not have space to publish them all.

While you have pen in hand, you might like to address the problem of technical information in general. Be philosophical if you like. How important is technical information as a national resource? As an international resource? Are you concerned about the "information explosion"? How do you perceive the policy of the U.S. Government with respect to technical information? I would be very much interested in the opinions of thoughtful readers on these and similar questions. Perhaps among those opinions will be gems of wisdom to promote the common good. I will look forward to hearing from you.

H.C.P.

ANNUAL SERVICE PACKAGE* OF THE SHOCK

PUBLICATIONS

BULLETINS — a collection of technical papers offered at the SHOCK AND VIBRATION SYMPOSIA published once a year. *Catalog listing back issues available from SVIC.*

DIGEST — a monthly publication of THE SHOCK AND VIBRATION INFORMATION CENTER containing abstracts of the current literature, continuous literature review, feature articles, news briefs, technical meeting calendar, meeting news, and book reviews.

MONOGRAPHS — a series of books on shock and vibration technology. Each author surveys the literature, extracts significant material, standardizes the symbolism and terminology and provides an authoritative condensed review with bibliography. *Brochure listing available monographs can be obtained from SVIC.*

SPECIAL PUBLICATIONS — special technology surveys, facility surveys, proceedings of special seminars and other publications as needed.

**For information on obtaining the SVIC Service Package including publications and services, contact the SVIC, Naval Research Laboratory, Code 8404, Washington, D.C. 20375, (202) 767-3306. These publications and services may also be obtained on an individual basis.*

AND VIBRATION INFORMATION CENTER

INFORMATION SERVICES

DIRECT INFORMATION SERVICE *	the Center handles requests for information via mail, telephone, and direct contact. The Center technical specialists, who are experts in the shock and vibration field, have the SVIC computer implemented SHOCK AND VIBRATION INFORMATION BASE at their disposal.
WORKSHOPS	workshops on shock and vibration technology are organized and sponsored by the Center. Experts on specialized technology give lectures and write articles for the workshop proceedings.
SYMPOSIA	annual shock and vibration symposia bring together working scientists and engineers for formal presentations of their papers and for informal information exchanges.

**See inside back cover for details*

Accession For
NTIS GRA&I ☑
DDC TAB ☐
Unannounced ☐
Justification
By
Distribution/
Availability Codes
Dist | Avail and/or special
A 21

EDITORS RATTLE SPACE

ABSTRACTS FROM THE CURRENT LITERATURE: NEW CATEGORIES

Abstracts from the Current Literature have been an important part of the DIGEST since the first issue was published in 1969. The purpose of the Abstracts is to provide the reader with short and objective descriptions of recent literature in acoustics, shock and vibration.

About 200 citations are selected each month from the more than 200 sources scanned -- journals, trade magazines, unclassified government and contractor reports, proceedings of technical meetings, and Ph.D. dissertations. Each citation includes a DIGEST accession number, title, names and addresses of authors, reference, key words, and the abstract. The citations are arranged in topical sequence so that the reader can quickly scan specific areas with minimal effort. In addition, the titles, authors, and key words of each citation are stored in a digital computer and thus are retrievable by means of the annual key-word listing. The indexing of citations, or key-word assignment has been standardized with the SHOCK AND VIBRATION THESAURUS -- an alphabetical list that has been continuously expanded since the DIGEST was first published. The THESAURUS, which contains both broadly defined and narrowly defined words, is also used in literature searches.

Citations are placed in one of the following categories: property, object, method. Key words describe material pertinent to a given topic; for example, experimental determination, theoretical calculation, or analysis of properties of certain objects -- components, materials, or systems -- by some method.

Abstract categories are listed in issues 1, 3, 6, 9, and 12 of the DIGEST. The major categories, arranged according to property, object, method, have been revised beginning with this issue of the DIGEST.

Property -	dynamic environment
	mechanical properties
Object -	mechanical systems
	structural systems
	vehicle systems
	biological systems
	mechanical components
	structural components
	electronic components
Method -	experimentation
	analysis and design
	conference proceedings and general topics

Categorization provides access on a month-to-month basis of specific topical information.

R.L.E.

MEANS FOR THE REDUCTION OF NOISE TRANSMITTED FROM SUBWAYS TO NEARBY BUILDINGS

E.E. Ungar* and L.G. Kurzweil**

Abstract - A brief overview is presented of how noise and vibration generated by passing subway trains reach buildings near subway tunnels. Various means for reducing the ground-transmitted noise and vibration are described, their effectiveness is discussed, and specific needs for further research are indicated.

In recent years there has been a resurgence of interest in the use of rail rapid transit systems in urban areas. New transit systems in San Francisco, Washington, and Atlanta have only begun service this decade. Other rapid transit systems are being built in Baltimore and Miami, and extensions are being constructed in Atlanta, Washington, Chicago, New York, New Jersey, and Boston. In view of the general concern with the quality of the environment, much consideration is being given to the vibration and the associated noise that passing trains may produce in buildings located near subway tunnels.

For the most part, research on the control of ground-transmitted noise (groundborne noise) and vibration from subway systems has been done on a piecemeal basis and the relevant information is widely scattered throughout the literature. The present article provides an overview of the technical information, discusses some of the practical problems, indicates a number of the considerations involved in selecting from among the available treatments, and points out some requirements for further research.

HOW SUBWAYS PRODUCE NOISE/VIBRATIONS IN NEARBY BUILDINGS

It is instructive to consider the physical mechanisms that are involved in the generation of noise/vibrations by subway train passages and in the propagation of these disturbances into buildings near subway tunnels. A review of these mechanisms enables one to obtain an insight into how noise/vibration control may be accomplished and permits one to organize one's thinking about control means, providing some assurance that no relevant items escape consideration.

The schematic shown in Figure 1 is intended to assist in the visualization of how subway-related noise and vibration are produced in buildings near subways. A train passing in a subway tunnel causes vibrations of the tunnel structure in two ways: direct (structure-borne) transmission of the wheel-rail interaction vibrations from the rail through the rail fasteners to the tunnel structure; and indirect (airborne) excitation of the tunnel by the sound (air pressure fluctuations) produced by the passing train. The directly induced vibrations generally far outweigh the indirectly induced ones. Thus, for all practical purposes, one may neglect the contribution that the airborne sound in the tunnel makes to vibrations of the tunnel structure and to the noise produced in nearby buildings.***

Unsteady forces are produced at the wheel-rail interface as a result of the interaction of the wheels and rails in the presence of roughness (deviations from ideally smooth wheel and rail surfaces), wheel irregularities (e.g., flat spots) and rail discontinuities (e.g., at joints, frogs, and switches). These forces produce vibrations of the rails, rail fasteners, track support structures (if any) and tunnel inverts. These vibrations propagate to the exterior tunnel structures and along these structures, and motions of their exterior surfaces communicate the vibrations to the adjacent soil. The vibrations then propagate through the soil, suffering some attenuation due to internal

**Principal Engineer, Bolt Beranek and Newman, Inc., 50 Moulton Street, Cambridge, MA 02138*

***Senior Project Engineer, U.S. DOT/Transportation Systems Center, Kendall Square, Cambridge, MA 02142*

****This airborne sound, however, establishes a limit on the reductions one can achieve by attenuating only the structureborne component, since the airborne contribution remains even if one eliminates the structureborne part entirely [1].*

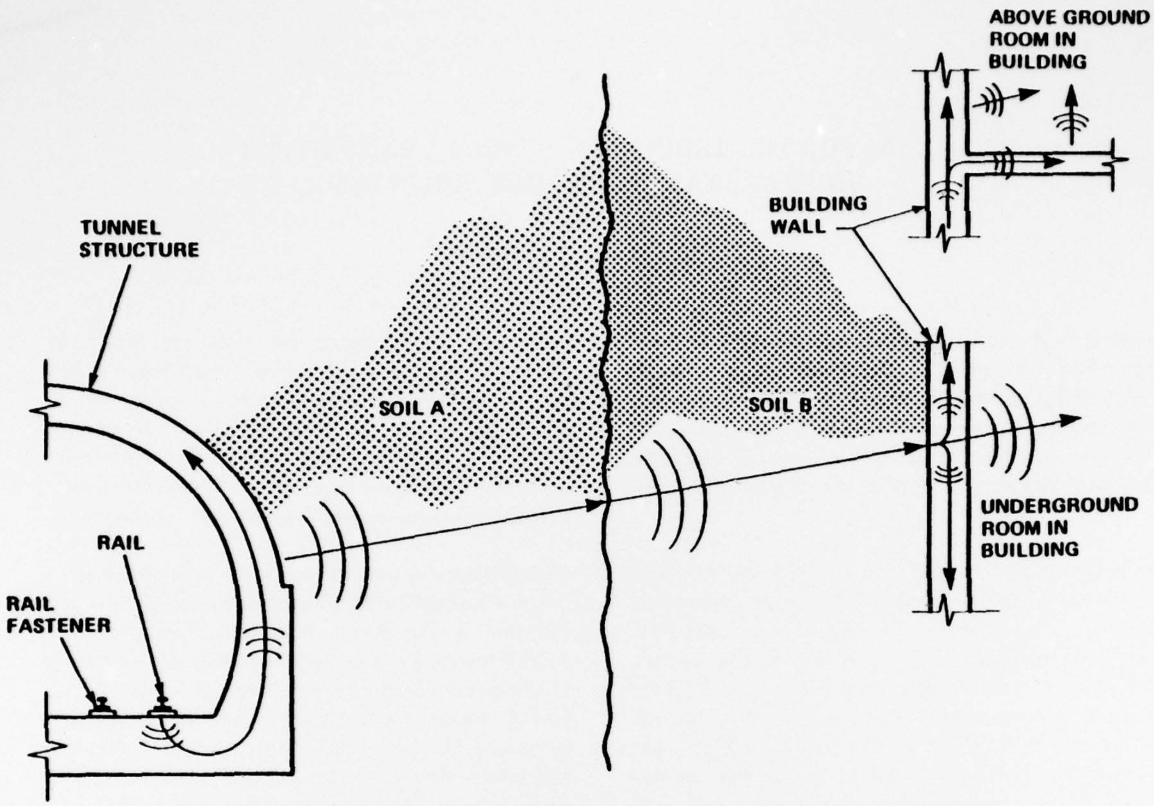


Figure 1. Schematic Representation of Propagation of Subway Noise/Vibration into Buildings

damping in the soil, as well as at any interfaces between different soil types, and setting into motion the underground walls of buildings. The wall vibrations propagate along the building structure to other parts of the building, and the vibrations of building structural components produce noise (audible sound) in spaces within the building in much the same way that a vibrating loudspeaker diaphragm generates sound. Although the schematic representation in Figure 1 shows only a single propagation path, it should be noted that in reality there may exist several paths of equal importance.

The wheel-rail interaction forces produce vibrations not only of the rails, but also of the vehicle wheels, suspension system and, potentially, of other vehicle components. Vehicle and suspension system vibrations may be particularly significant if lightly damped resonances occur. These vibrations tend to react on the wheels, which in turn act on the rails, again leading to noise and vibrations in nearby buildings as described previously.

For modern transit cars and tracks, the vibrations induced in nearby buildings due to subway train passages are below the threshold of perception in most instances. However, the associated audible noise, typically a low frequency rumbling, can still be of sufficient intensity to create a significant intrusion.

MEANS FOR REDUCTION OF GROUNDBORNE NOISE

In the light of the foregoing discussion, one may observe that reduction of subway-induced noise/vibrations in nearby buildings can be achieved in two conceptually different ways: (1) by reducing the unsteady wheel-rail interaction, thus decreasing the source of the undesirable effects, and (2) by attenuating the propagation of vibrations, thus decreasing the intensity of the noise/vibrations that reach the buildings. However, some vibration control techniques, particularly those that involve insertion of resilient elements near the rail, affect both the wheel-rail interaction and the propagation of vibrations; thus, these two categories are not mutually exclusive.

Source Reduction

Wheel truing serves to reduce discontinuities that may be present on the wheel surface, such as flats, and also reduces wheel roughness. Because it is the interaction of the wheel and the rail that counts, wheel truing produces useful vibration reductions only if the rail is relatively smooth, i.e., free from corrugations and worn rail joints. If worn rail conditions exist, therefore, a wheel truing program is effective only if undertaken in conjunction with a rail grinding and/or a joint maintenance program. Similarly, rail grinding, which reduces rail roughness, is useful only in conjunction with smooth wheels. As one would expect, the magnitude of the vibration reduction that can be achieved by wheel truing and rail grinding depends on the magnitude of the initially present surface irregularities; these processes can produce greater reductions in roughness and groundborne noise for wheels and rails that are initially rougher and noisier [2]. Wheel flats, bad rail joints, or corrugated rail can increase vibration levels by 10 to 20 dB compared to smooth wheels running on smooth continuous welded rail [3].

Means for preventing the occurrence of wheel and rail irregularities can reduce the need for wheel truing and rail grinding. Thus, the use of non-slip brake systems, which reduce the incidence of flat spot formation, may contribute to the continuing reduction of noise due to wheel-rail interaction. The causes of wheel flats and of rail corrugation are not fully understood; related research and the development of means for preventing these phenomena are needed.

Any arrangement that reduces the severity of impacts which occur as wheels traverse rail joints also may be expected to contribute to reduction of the associated noise/vibration. Replacement of jointed with continuous welded rail is most beneficial in this regard, since welded joints (if properly ground) do away with rail joint discontinuities altogether. Careful maintenance and alignment of bolted joints is beneficial where such joints are present, particularly in order to avoid alignments that make the wheels "step up" at a joint [4, 5]. Similarly, one may expect noise control benefits from the use of designs of switches and frogs (e.g., moving point frogs) that reduce impacts and smooth the transition of the wheel load from one rail segment to the next.

The level of vibration resulting from wheel-rail interaction typically increases by 4 to 6 dB per doubling of train speed [3]. Thus, noise/vibration reductions may be achieved at the cost of train speed -- a sacrifice that usually is unacceptable.

Resonances in vehicle suspension systems can cause groundborne noise problems [6], particularly if the resonant motions are lightly damped. Two approaches are likely to be useful here: 1) detuning the suspension system -- e.g., changing its spring characteristics so that its resonance frequencies are shifted toward regions where less excitation is present (e.g., [7]), or where the vibrations are less noticeable, tactually or audibly, and 2) increasing the system damping, in order to reduce the severity of the resonant motions resulting from a given excitation. In modern rail transit vehicles it is essentially only the primary suspension (i.e., resilience between the axles and the truck frame) that affects groundborne noise.

Resilient wheels permit the wheel contact point to deflect more (and the rail less) due to a given wheel-rail asperity, therefore reducing the rail vibrations and the corresponding noise in nearby buildings. Resilient wheels also constitute a part of the suspension system; thus, replacement of standard wheels with resilient ones also leads to changes in the resonance frequencies and damping characteristics of these systems [2, 4]. Resilient wheels have been reported to reduce tunnel vibration levels by 4 to 10 dB in the frequency range from 40 to 250 Hz [2, 8].

Resilient rail or compliant rail, consisting essentially of a rail head, supported by continuous rubber strips on both of its sides, has been developed and tested in Japan, with some success [9]. The isolating effect of the rubber strips here tends to reduce the vibrations that are transmitted to the track support structures. Since resilient rail deflects more due to a given wheel-rail asperity than conventional rail, the railhead itself vibrates more, but the wheel less; compliant rail thus negates some of the effect of resilient wheels.

The use of damped wheels, or of wheels provided with damping rings or with viscoelastic damping treatments, generally results in reductions of only the high-frequency vibrations associated with wheel screech noise, which play no significant role in relation to the groundborne noise in nearby buildings. The use of damped rail may reduce the noise in nearby buildings if the damping attenuates those resonant motions of the rail/rail-fastener system which contribute significantly to that noise.

Resilient Track Support Structures

Resilient rail fasteners tend to isolate the vibrating rail from the ties or other components to which the rail is fastened. The groundborne noise reduction benefit of resilient fasteners generally increases with their compliance (or "dynamic softness"). For resilient rail fasteners which are more compliant than the tunnel structure, a halving of the rail support modulus (i.e., fastener stiffness divided by fastener spacing) results in a 6 dB reduction in tunnel vibration levels for frequencies above about 50 Hz [8, 10, 11, 12]. The maximum compliance (minimum rail support modulus) that can be used in practice is limited by rail stability and strength requirements [13, 14]. As yet, there is no general consensus on the optimum value of the rail support modulus. Suggested values are of the order of 2000 lb/in^2 [14] to 3000 lb/in^2 [15], but analysis and testing are needed to determine the best value for specific installations.

In floated tie systems, a resilient element (typically, a rubber or fiberglass mat) is placed between the tie and the invert, whereas in resilient rail fasteners a compliant element is used between the rail and the tie. In relation to groundborne noise reduction, floated ties have much the same dynamic effect as resiliently fastened track, but floated ties may have some construction and maintenance advantages.

Whereas with resilient rail fasteners and with floated ties the mass atop the resilient supports is dominated by that of the unsprung portion of the car's suspension system, several arrangements exist where the "floated mass" is significantly greater. These arrangements include floated slabs, floated slablets (also sometimes called floated mini-slabs or double ties) and ballast beds atop resilient ballast mats. In such floated mass systems, the inertia of the floated mass reduces its vibratory motions at the frequencies of interest. These motions are transmitted to the invert via relatively soft resilient supports, resulting in reduced vibratory forces acting on the invert. Figure 2 illustrates the vibration reductions achieved by means of such floated mass systems, which are generally the most effective of the available methods for reducing groundborne noise.

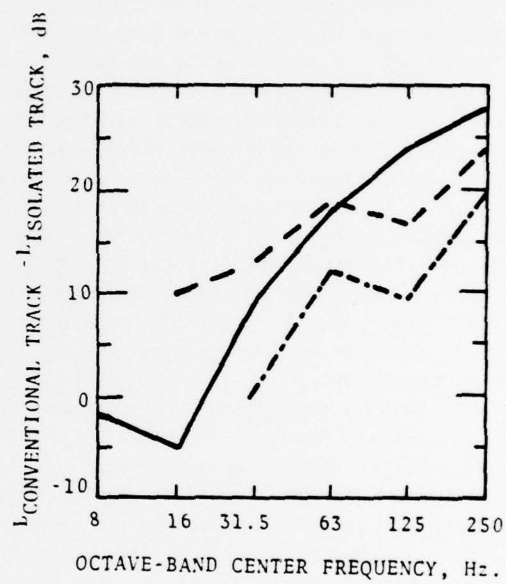


Figure 2. Difference between Tunnel Vibration Levels for Conventional Track and Various Isolated Track Systems. ——, New York Continuous Floated Slab Track [16]; - - -, Frankfurt Floated Mini-Slabs [17]; –·–, Tokyo Ballast Mat [18]

The effect of increasing the ballast bed thickness (in absence of ballast mats) on the vibration levels due to subway trains has not been determined conclusively. In one case an increase in ballast bed thickness from 30 cm to 70 cm was reported to have provided no vibration reduction [19], but in another case, a 5 1/2 dB reduction at 80 Hz was observed due to a ballast thickness increase from 20 cm to 30 cm [20].

Tunnel Construction, Trenches, and Barriers

Tunnel configurations that vibrate less in response to given excitation forces may be expected to transmit less intense vibrations to their surroundings. Thus, more massive tunnel structures generally may be expected to result in less noise/vibration in neighboring buildings. There is limited evidence that concrete double box tunnel structures result in a few dB less noise than cast iron or steel structures, and that significant noise reductions may be achieved by major increases in the tunnel wall thickness [17, 21, 22].

The reported tunnel wall vibration reductions associated with thickness changes range from 5 to 18 dB per doubling of the wall thickness [17, 19, 22-24]. Further research is needed to provide better estimates of the effects of tunnel wall thickness and of tunnel/soil interaction. Although increased tunnel wall thicknesses imply increased construction costs, greater thickness designs may merit consideration for controlling groundborne noise. Such increases may provide the desired noise reduction more inexpensively, more reliably, and with less maintenance requirements than, say, floated slab track in a thinner walled tunnel.

The transmission of tunnel vibrations to the adjacent soil depends also on how well the tunnel is coupled to the soil. This coupling may be reduced by the construction of barriers or trenches along tunnels, in their immediate vicinity. Deep trenches near a tunnel can provide significant noise reductions [25], but rarely are practical. Trenches that are backfilled to improve their stability tend to lose most of their noise control effectiveness [26].

Barriers, or "underground walls" have not been considered extensively for the reduction of a subway-related noise. Theoretical considerations and limited tests have shown that such barriers are likely to be less effective than back-filled trenches [27, 29] and thus to be not worth their costs.

By injecting grout into sandy or otherwise loosely aggregated soil, one may be able to obtain the dynamic effect of a barrier at much reduced cost. This injection process, which has been developed for soil stabilization purposes, may be expected to change the elastic properties of the soil, and thus to produce a section of soil with modified elastic properties embedded in the remaining unmodified soil. A study of the noise reduction potential of grout injection is in progress.

One may consider the placement of trenches and barriers in the immediate vicinity of buildings one wants to protect, instead of building such trenches along the tunnel. This arrangement may be favorable where there exist only a few concentrated vibration/noise-sensitive areas, but suffers from the same effectiveness limitations as all trenches and barriers.

Isolation of Buildings and Rooms

Insertion of isolation pads in buildings under foundation piles, at column bases or crowns, and at other structural connections can assist in protecting selected buildings or areas within buildings from noise and vibrations. Lead-asbestos pads have found considerable use for this purpose, but relevant available technical data is limited [30]. Neoprene bearing pads have been used with some success in several recently built structures. Installation of isolating pads usually makes sense only for new construction, not only because of the physical difficulties, but also because the use of such pads reduces a building's stability and needs to be considered in the design of its structure.

Where one needs to provide a quiet environment in only a few rooms in existing buildings, one may consider construction of a "room within a room" for each space of concern. This amounts to providing room floors that "float" on the structural floors, as well as room walls and ceilings that are isolated dynamically from the structural walls and ceilings.

In all building isolation designs, care must be taken to interrupt all significant vibration transmission paths or to provide them with effective isolation. Otherwise, the noise/vibration will propagate along these "short circuits" or "sound bridges," largely negating the noise control achieved by the isolation that is used.

CONCLUDING REMARKS

Most of the publications which contain data on the effectiveness of various treatments for the reduction of groundborne noise from subways report measured reductions of the vibrations of tunnel inverts or walls, rather than noise reductions measured in buildings near subways. It is usually necessary to estimate the noise reductions from the available vibration reduction data. The estimation process typically assumes that: (a) the noise reductions obtained in a building in each one-third or full octave band (in decibels) are equal to the reductions of tunnel structure vibrations in the same band, and (b) the A-weighted noise obtained in buildings due to subways is dominated by contributions in the 60 to 250 Hz region. The first of these assumptions is widely accepted (see e.g., [3]), and the second is in agreement with available data (see e.g., [23, 31]). Variations in the estimated noise reductions for a given treatment may occur not only due to differences in the reported vibration reductions, but also due to differences in the shapes of the vibration and noise spectra; for differently shaped spectra, a given frequency distribution of vibration reductions can result in different reductions in the overall A-weighted noise levels.

Most of the available literature on this subject does not include adequate information concerning the values of the dynamic parameters (e.g., masses, stiffnesses, resonance frequencies, damping factors) that control the noise/vibration reduction behavior of the noise control means studied. Because variations in these parameters may be expected to have major effects on the noise reductions that these installations provide, it is not surprising that the reported noise reductions vary widely for different systems of the same nominal type. It is clear that these dynamic parameters must be taken into account adequately in the selection of a noise control installation for any specific situation.

ACKNOWLEDGEMENTS

A major portion of the information presented in this paper has been taken from a Bolt Beranek and Newman Inc. report prepared in part under a grant from the U.S. Department of Transportation, Urban Mass Transportation Administration (UMTA). A part of the work leading to this paper was performed at the Transportation Systems Center under the UMTA-sponsored Urban Rail Noise Abatement Program. Many of the remarks concerning the selection from alternative treatments and the requirements for further research were based upon a review performed by Wesley N. Cobb while at the Transportation Systems Center.

REFERENCES

1. Heckl, M., "Die theoretisch erreichbare Körperschalldämmung bei schotterlosem Oberbau" (The Theoretical Limit of Structureborne Noise Reduction for Tracks Without Ballast), VDI-Berichte Nr. 217, pp 15-18 (1974).

2. Saurenman, H.J., "In-Service Performance and Costs of Methods to Control Urban Rail System Noise-Second Test Series Report," U.S. DOT Report No. UMTA-MA-06-0099-79-4 (1979).

3. Kurzweil, L.G., "Ground-Borne Noise and Vibration from Underground Rail Systems," J. Sound Vib., 66 (3) (1979).

4. Remington, P.J., Rudd, M.J., and Ver, I.L., "Wheel/Rail Noise and Vibration," U.S. DOT Report Nos. UMTA-MA-06-0025-75-10 and -11 (Two Volumes) (May 1975).

5. Ver, I.L., Ventres, C.S., and Myles, M.M.,"Wheel/Rail Noise, Part III: Impact Noise Generation by Wheel and Rail Discontinuities," J. Sound Vib., 46 (3), pp 395-417 (1976).

6. Paolillo, A.W., "Groundborne Vibration Generated by Rapid Transit Rail Cars," Paper presented at the American Public Transit Assoc. (APTA) Rapid Transit Conference, Chicago (June 1978).

7. Keevil, W.R., "Noise and Vibration in Rapid Transit Trucks," Paper presented at American Public Transit Association (APTA) Rapid Transit Conference, Chicago (June 1978).

8. Wilson, Ihrig and Associates, Inc., "Yonge Subway Northern Extension Noise and Vibration Study - Measurement Program Results," Report RD 115/3, Toronto Transit Commission (Oct 1976).

9. Satoh, Y., Umekubo, S., Hirata, G., Arai, M., Chino, T., Tsukamoto, K., and Sawado, T., "Resilient Rail," Tokyo Railway Technical Research Institute Journal (RTRI), 13 (2), pp 76-84 (1972).

10. Wilson, G.P. and Murray, R.J., "Environmental Impact of Subway Rapid Transit Systems," Inter-Noise 74, pp 235-240 (1974).

11. Bender, E.K. et al, "Predictions of Subway-Induced Noise and Vibrations in Buildings Near WMATA, Phase I," Bolt Beranek and Newman Inc. Report No. 1823 (1969).

12. Paolillo, A.W., "Control of Noise and Vibration in Buildings Adjacent to Subways - A Case History," Noise-Con 73, pp 152-157 (1973).

13. Manning, J.E., Cann, R.G., and Fredberg, J.J., "Prediction and Control of Rail Transit Noise and Vibration - A State-of-the-Art Assessment," U.S. DOT Report No. UMTA-MA-06-0025-74-5 (1974).

14. Bender, E.K., "Rail Fastener Design for Noise and Vibration Control," Bolt Beranek and Newman Inc. Report 2485 (1974).

15. Wilson, Ihrig and Associates, Inc., "Noise and Vibration Design Criteria and Recommendations - Baltimore Region Rapid Transit System," (1974).

16. Manning, J.E., Hyland, D.C., and Tocci, G., "Vibration Prediction Model for Floating - Slab Rail Transit Track," U.S. DOT Report No. UMTA-MA-06-0025-75-13 (1975).

17. Hauck, G., Willenbrink, L., and Stüber, C., "Körperschall- und Luftschallmessungen an unterirdischen Schienenbahnen. Teil 2" (Measurements of Structure-borne and Airborne Sound in Underground Railways, Part 2), Eisenbahntechnische Rundschau, pp 310-321 (July/Aug 1973).

18. Fujiwara, T., Nakamura, S., and Kazamaki, T., "Vibration Reduction by Vibration-Proof Mats in Tokyo Subway," Permanent Way, 15 (3), No. 56, pp 28-33 (Mar 1974).

19. Stüber, C., "Geräusche von Schienenfahrzeugen," (Noise from Rail Vehicles), Chapter 15 in Taschenbuch der Technischen Akustik (Pocketbook of Technical Acoustics), Edited by M. Heckl and H.A. Müller, Springer-Verlag, Berlin (1975).

20. Steinbeisser, L., "Körperschallmessungen in Zürich und München," (Structureborne Noise Measurements in Zurich and Munich), VDI-Berichte Nr. 217, pp 37-42 (1974).

21. Nelson, J.T., "Ground-borne Vibration from Rail Rapid Transit Operations," Paper presented at 92nd Meeting of Acoustical Society of America, San Diego (1978).

22. Koch, H.W., "Körperschallpegel bei mehrjährig befahrenem Oberbau und bei abgeändertem Schotteroberbau sowie vergleichsfähige Werte," (Levels of Structureborne Sound for Track Support Structures in Multi-Year Use and for Structures with Altered Ballast, as well as Values Applicable for Comparisons), VDI-Berichte Nr. 217, pp 19-20 (1974).

23. Hauck, G., Willenbrink, K., and Stüber, C., "Körperschall- und Luftschallmessungen an unterirdischen Schienenbahnen," (Measurements of Structure-borne and Airborne Sound in Underground Railways), Eisenbahntechnische Rundschau, pp 289-300 (July/Aug 1972).

24. Kazamaki, T. and Watanabe, T., "Reduction of Solid-borne Sound from a Subway," Inter-Noise 75, pp 85-92 (1975).

25. Ikeda, K., "Vibration of Ground Aroused by Trains and Other Dynamic Loads," Japanese National Railways RTRI 4, pp 15-16 (1965).

26. Shito, K., Oikawa, A., and Kazamaki, T., "Noise and Vibration Reducing Effect of the Trench Provided in the Soil Connecting the Underground Railway Tunnel and the Building Nearby," Inter-Noise 75, Sendai, Japan, pp 387-390 (1975).

27. Ungar, E.E. and Bender, E.K., "Vibrations Produced in Buildings by Passage of Subway Trains; Parameter Estimation for Preliminary Design," Inter-Noise 75, pp 491-498 (1975).

28. Richard, F.E., Hall, J.R., and Woods, R.D., Vibrations of Soils and Foundations, Prentice-Hall, Inc., New York (1970).

29. Kazamaki, T., "Subway Vibration Control," Permanent Way 18, (1, 2), No. 66-67, pp 38-53 (Feb 1977).

30. Miller, L.N., "Isolation of Railway and Subway Noise and Vibration," Progressive Architecture, pp 203-208 (Apr 1965).

31. Ungar, E.E., Wittig, L.E., and Paolillo, A., "Propagation of Vibrations and Noise from New York Subway Tunnels into Nearby Buildings," Inter-Noise 79, pp 919-922 (Sept 1979).

LITERATURE REVIEW

survey and analysis of the Shock and Vibration literature

The monthly Literature Review, a subjective critique and summary of the literature, consists of two to four review articles each month, 3,000 to 4,000 words in length. The purpose of this section is to present a "digest" of literature over a period of three years. Planned by the Technical Editor, this section provides the DIGEST reader with up-to-date insights into current technology in more than 150 topic areas. Review articles include technical information from articles, reports, and unpublished proceedings. Each article also contains a minor tutorial of the technical area under discussion, a survey and evaluation of the new literature, and recommendations. Review articles are written by experts in the shock and vibration field.

This issue of the DIGEST contains articles on transient problems of submerged elasto-plastic structures, and recent advances in helicopter vibration control.

Professor Dusan Krajcinovic of the University of Illinois at Chicago Circle has written a paper reviewing some basic problems in dealing with submerged structures deforming plastically when subjected to transient loads. The paper also lists some of the available literature on the title problem.

Professor G.T.S. Done of The City University, London, England has written an article describing the advances that have been made in the past three years in the control of forced vibration excitation and response of helicopter airframes. Methods and hardware for vibration control, including isolators, absorbers, direct rotor control, and structural modification are considered.

SOME TRANSIENT PROBLEMS OF SUBMERGED ELASTO-PLASTIC STRUCTURES

D. Krajcinovic*

Abstract - The paper reviews some basic problems in dealing with submerged structures deforming plastically when subjected to transient loads. The paper also lists some of the available literature on the title problem.

The interaction of a structure with ambient fluid is a phenomenon of theoretical and practical importance in such engineering fields as acoustics, aeroelasticity, naval and ocean engineering, and reactor engineering. The needs of aircraft and aerospace engineering and restrictions imposed by the complexities of the problem have meant that structures have, almost as a rule, been considered as elastic. However, in certain applications, a structure submerged in fluid is subjected, usually accidentally, to loads of extremely high intensity and short duration; in such cases there is a probability of the appearance of stresses beyond the elastic limits. Determination of the load-carrying capability of such a structure, as well as damage incurred in the form of residual (plastic) deformation, requires consideration of elasto-plastic response of the structure.

The elasto-plastic response of dynamically loaded cylindrical shells submerged in acoustic medium is an enormously complex phenomenon. The time-dependent load, inertia forces, and fluid resistance (radiated pressure) cause the regions of plastic stresses in the shell to appear, grow, move, shrink, and disappear only to appear again. Mathematically, the problem is governed by two systems of partial differential equations in the shell; one is for the elastic and the other for plastic regions. The wave equation represents the fluid (external domain). The systems of equations are coupled by matching conditions on moving boundaries; this matching process further complicates the problem.

It is well beyond present capability to solve so complex a problem using purely conventional analytical techniques. Completely numerical solutions -- such as general purpose computer codes based on either finite differences or the finite element method -- for fluid-structure interaction problems are in early developmental stage. However, their use is prohibitively expensive, especially when the analysis must be repeated several times during a search for an optimal design.

The paucity of literature dealing with the elasto-plastic response of dynamically loaded submerged structures, in view of the importance of the problem, reflects its complexity. Most of the literature is concerned either with rigid-ideally plastic shells deforming in vacuum or with elastic shells immersed in fluid. Surveys and state-of-art reviews of the literature are available on dynamic plasticity [1-6] and fluid-structure interaction [7-10]. In general, authors differ, usually in the degree of approximation they deem necessary for making the problem solvable. Unfortunately, every simplification restricts the domain of the validity of the model.

One of the few possibilities for a closed-form solution for the dynamic-plasticity problem is contingent on a rigid-ideally plastic representation for the material. In many cases, however, the rigid-ideally plastic theory, does not provide reliable estimates of the deformation. Even a drastic simplification – for instance, one that ignores elastic deformations altogether, does not necessarily lead to simple results in the case of cylindrical shells.

The elasto-plastic deformation of structures subjected to dynamic loading does not lend itself to solutions based on conventional analytical techniques. The numerous loadings and unloadings and the motion of

**Professor of Structural Engineering, Department of Materials Engineering, University of Illinois at Chicago Circle, 60680*

the elasto-plastic interface attributable to the elastic component of the deformation can cause monumental problems even in simple cases.

Many authors [1] have addressed the beam problem by matching modes at the elasto-plastic interface. Although the method seems straightforward in principle, the computations are arduous and convergence is both slow and uncertain. An extension of this method led to a more judicious examination of modal approximation and determination of the best approximation. However, the presence of fluid will require substantial modification of the modal approximation technique. Certain commercially available general purpose codes -- typically based on the finite element method -- could be used for the dynamic analysis of elasto-plastic structures deforming in vacuum if some significant problems associated with the technique were satisfactorily resolved. Moreover, as a result of their very nature these codes are very expensive to use and, therefore, unsuitable for early design stages.

The presence of fluid enveloping the deforming structure enormously complicates the problem. The dynamic response of an elastic shell interacting with an enveloping acoustic fluid can be described by a system of partial differential equations for the shell and the wave equation for the fluid. The systems of equations are coupled through the matching conditions on the interface. The difficulties associated with this type of problem have been discussed [7, 11, 12].

In transient problems, the main obstacle is solving the wave equation in the exterior domain in terms of the boundary conditions on the shell-fluid interface. The lack of a rigorous closed-form solution for a general case provided strong impetus for numerous approximations of the actual phenomenon. Better known approximations include the plane wave approximation [9], cylindrical wave approximation [9], doubly asymptotic approximation [9], and the incompressible fluid approximation. The piston theory -- based on the approximation of the shell boundary-plane and cylindrical wave model -- is generally accurate during the early stages of deformation. The incompressible fluid model leads to useful result for the latter part of the response.

Instead of modifying or manipulating the wave equation, several Russians [7, 11, 13] used an appropriate approximation for the Laplace transform of the fluid velocity potential: functions for which the quadrature of the convolution integral becomes possible in closed form. As a result they were able to derive an approximate closed-form solution for the radiated pressure in each deformation mode. They were also able to show that the devised model contains both the plane wave and incompressible fluid approximation. Klosner [9] demonstrated the connection between this method and the doubly asymptotic approximation.

It is important to point out that proper selection of the approximate model for fluid flow also depends on the wavelength of the shell deformation mode (spacing of reinforcing ribs vs. shell radius) and the ratio of sound speeds in the fluid and the shell. As has been shown [9], some approximation methods -- i.e., the plane wave and cylindrical wave models -- lead to misleading results whenever the deformation of the shell is dominated by its undamped component. This is not surprising because the radiated pressure is, according to the plane reflection model, proportional to the velocity of the radial deformation of the shell (having in essence the effect of viscous damping).

Both dynamic plastic behavior of structures deforming in vacuum and fluido-elastic problems are difficult to analyze; it is not surprising, therefore, that little work has been reported on elasto-plastic response of structures enveloped by fluid.

The closed-form analytical solutions for a dynamically loaded rigid-ideally plastic beam and a circular plate (axisymmetric case) resting on incompressible and Newtonian fluid have been derived [14-17]. The results indicate that the influence of fluid resistance (so-called virtual mass) is substantial. The increased inertia of the structure-fluid system was found to be a linear function of $a\gamma_f/h\gamma_s$ where a and h are the span and the thickness of the structure; γ_f and γ_s are the mass densities of the fluid and the structure. The increase in inertia thus depends on both the density and the geometric ratio.

The dynamic response of an infinitely long rigid-ideally plastic cylindrical shell immersed in potential fluid and subjected to axially symmetric internal blast has been studied [18-20]. The Fourier cosine transform was used on the Neumann problem for the potential equation in the exterior of a circular shell; the added (virtual) mass was determined in the form of an integral intractable in closed form. The solution was obtained using asymptotic formulas and Filon's method. The computed results demonstrated the significance of fluid resistance on the magnitude of plastic deformation. A modestly conceived parametric study has been reported [19]. The model consisted of a rigid ideally-plastic shell and potential (inviscid and incompressible) fluid; the final displacement, however, depended on eight non-dimensional numbers. Such complexity demonstrates the enormity of the problem.

The axisymmetric problem of viscoelastic spherical shells and plastic rings surrounded by acoustic medium has been studied [21, 22]. A more comprehensive study of a rotationally symmetric transient response of a viscoelastic and visco-plastic spherical shell submerged into inviscid but compressible fluid has also been reported [23]. Duffey considered linear strain hardening, linear and nonlinear strain-rate sensitivity (in conjunction with plane wave approximation), and viscoelastic (Kelvin-Voight and Maxwell materials). The computed results showed that the peak displacements were significantly altered by strain hardening, strain-rate sensitivity, and viscoelastic properties.

Somewhat earlier, Testa and Bleich [24] developed an approximate solution for a floating rigid-plastic box (subjected to a shock wave); they used a modified virtual mass approach. Another paper [25] emphasized solutions related to naval problems.

In view of the complexity of the problem the increasing activity in developing rather general fluid-structure interaction computer codes was both inevitable and desirable. An excellent review of discrete element methods applied to submerged structures is that of Geers [26]. His discussion of the computational efficiency and applicability (in terms of accuracies in specific frequency domains) of various approaches is especially revealing.

The emergence of several competing approaches were best demonstrated at a recent SMIRT Conference [27]. Methods are based on Lagrangian, Eulerian or quasi-Eulerian methods, different treatments of fluid-structure interfaces, and free surfaces. The fluid elements have been added to SAP IV, Ansys, and Nastran. Fluid elements were derived based on Navier-Stokes equations, assuming constancy of the pressure field within an element, and for inviscid fluid.

Other important papers have appeared [22, 27, 30-32]. In addition, the finite difference scheme has been used for reactor containments [33] and for pipe analyses [34]. The method of characteristics was used to solve the problem of plastic deformation of a pipe conveying fluid [35, 36].

A technique as powerful as finite elements provides the opportunity to eliminate simplifications introduced to make an analytical solution possible. Nevertheless, various problems persist. Modeling a structure in a large pool of fluid implies necessity for a disproportionate number of fluid elements even though the interest invariably rests in the structure. It is necessary to introduce special elements that will not reflect waves at the boundary. The deformability of the fluid causes large distortions of the mesh and necessitates frequent re-meshing (or use of Eulerian formulation). Problems of cavitation are not addressed. However, there is little doubt that success in dealing with problems of elasto-plastic response of structures submerged in fluid will, to a large extent, depend on the further development of numerical techniques. This, of course, does not preclude the need for further analytical results and experimental data. A careful parametric study of this type of problem and subsequent elimination of less significant parameters will facilitate development of numerical techniques.

REFERENCES

1. Symonds, P.S., "Survey of Methods of Analysis for Plastic Deformation of Structures under Dynamic Loading," Rept. BU/NSRDC/1-67, Brown University (1967).

2. Krajcinovic, D., "Dynamic Response of Rigid-Ideally Plastic Structures," Shock Vib. Dig., 5 (2), pp 1-8 (1973).

3. Jones, N., "A Literature Review of the Dynamic Plastic Response of Structures," Shock Vib. Dig., 7 (8), pp 89-105 (1975).

4. Jones, N., "Recent Progress in the Dynamic Plastic Behavior of Structures," Shock Vib. Dig., 10 (10), pp 13-19 (1978).

5. Baker, W.E., "Approximate Techniques for Plastic Deformation of Structures under Impulsive Loading," Shock Vib. Dig., 7 (7), pp 107-117 (1975).

6. Rawlings, B., "Response of Structures to Dynamic Loads," in Mechanical Properties at High Rates of Strain, ed. by J. Harding, publ. by Inst. of Physics (London), Conf. Series No. 21, pp 279-298 (1974).

7. Mnev, Ye.N. and Pertsev, A.K., "Hydro Elasticity of Shells," NTIS, U.S. Dept. of Comm., AD-731646, Springfield, VA (1970).

8. Grigoliuk, E.I., "Problems of Shells Interacting with Fluid," in Trudi VII Vsesoinznoi Konf. po Teorii Obolochek i Plastinok, Nauka, Moscow (1970) (In Russian).

9. Klosner, J.M., "Response of Shells to Acoustic Shocks," Shock Vib. Dig., 8 (5), pp 3-13 (1976).

10. Krajcinovic, D., "Some Transient Problems of Structures Interacting with Fluid," Shock Vib. Dig., 9 (9), pp 9-16 (1977).

11. Zamishliaev, B.V. and Iakovlev, Yu.S., "Dynamic Loads Due to Underwater Shocks," Sudostroenie, Leningrad (1976) (In Russian).

12. Junger, M.C. and Feit, D., "Sound, Structure and Their Interaction," M.I.T. Press (1972).

13. Fedorovich, Yu.A. and Fedorovich, T.K., "Vibration of Two-Mass System Shell-Elastic Link-Weight under the Action of the Acoustic Pressure in Fluid," Stroit. Mekh. Korablia, 110, pp 39-47, Sudostroenie, Leningrad (1968) (In Russian).

14. Krajcinovic, D., "Dynamic Plastic Response of Beams Resting on Fluid," Intl. J. Solids Struc., 77 (11), pp 1235-1243 (1975).

15. Krajcinovic, D., "Dynamic Response of Circular Rigid-Plastic Plates Resting on Fluid," J. Appl. Mech., Trans. ASME, 43 (1), pp 102-106 (1976).

16. Krajcinovic, D., "Dynamic Response of Floating Circular Plates," Proc. 12th Ann. Mtg. Soc. Engr. Sci., Austin, TX (1975).

17. Krajcinovic, D., "Response of a Rigid Plastic Circular Plate in Contact with Newtonian Fluid," J. Appl. Mech., Trans. ASME, 45 (1), pp 199-202 (1978).

18. Srinivasan, M.G., Krajcinovic, D., and Valentin, R.A., "Dynamic Plastic Response of an Immersed Pipe," J. Pressure Vessel Tech., Trans. ASME, 99, pp 563-567 (1977).

19. Srinivasan, M.G., Valentin, R.A., and Krajcinovic, D., "Influence of Fluid on the Dynamic Plastic Response of a Pipe," Shock Vib. Bull., U.S. Naval Res. Lab., Proc., No. 47, Pt. 4, pp 9-20 (1977).

20. Krajcinovic, D., Srinivasan, M.G., and Valentin, R.A., "Fluid Plasticity of Thin Cylindrical Shells," Proc. 13th Ann. Mtg. Soc. Engr. Sci., Hampton, VA (1976).

21. Workman, G. and Hayek, S.I., "Transmission of Acoustic Waves through Submerged Viscoelastic Spherical Shells," J. Acoust. Soc. Amer., 46, pp 1340-1349 (1969).

22. Ching, L.K.W. and Weese, J.A., "The Explosive Forming of Rings," Proc. 2nd Intl. Conf. Center for High Energy Forming, Estes Park, CO (June 1969).

23. Duffey, T.A., "Transient Response of Viscoplastic and Viscoelastic Shells Submerged in Fluid Media," J. Appl. Mech., Trans. ASME, 43, pp 137-143 (1976).

24. Testa, R.B. and Bleich, H.H., "Dynamic Response of a Floating Rigid-Plastic Box," ASCE J. Engr. Mech. Div., 92 (EM2), pp 131-151 (1966).

25. Keil, A.H., "Problems of Plasticity in Naval Structures," In Plasticity: Proceedings of the II Symposium on Naval Structural Mechanics, ed. by E.H. Lee and P.S. Symonds, Pergamon Press (1960).

26. Geers, T.L., "Transient Response Analysis of Submerged Structures," in Finite Element Analysis of Transient Nonlinear Structural Behavior, ed. by T. Belytschko, J.R. Osias, and P.V. Marcal, ASME, AMD - Vol. 14 (1975).

27. Trans. 5th Intl. Conf. Struc. Mech. Reactor Tech., Vol. B, Thermal and Fluid/Structure Dynamics Analysis (1979).

28. Nahavandi, A.N., Bohm, G.J., and Pedrido, R.R., "Structurally Compatible Fluid Element for Solid Fluid Interaction Studies," Nucl. Engr. Des., 35, pp 335-347 (1975).

29. Donea, J., Fasoli-Stella, P., and Guiliani, S., "Lagrangian and Eulerian Finite Element Techniques for Transient Fluid-Structure Interaction Problems," Trans. Struc. Mech. Reactor Tech. IV, Vol. B, B1/2 (1977).

30. Belytschko, T.B. and Kennedy, J.M., "Computer Models for Subassembly Simulation," Nucl. Engr. Des., 49 (1/2), pp 17-38 (1978).

31. Belytschko, T.B., Kennedy, J.M., and Schoeberle, D.F., "Quasi-Eulerian Finite Element Formulation for Fluid-Structure Interaction," ASME Publ. 78-PVP-60, Pressure Vessels and Piping Conf., Montreal (1978).

32. Nikolakopolou, G. and DiMaggio, F., "Dynamic Elastic-Plastic Response of a Containment Vessel to Fluid Pressure Pulses," Computers Struc., 10, pp 659-667 (1979).

33. Wang, C.Y., "Analysis of Nonlinear Fluid Structure Interaction Transient in Fast Reactors," Rept. ANL-78-103, Argonne Natl. Lab. (Nov 1978).

34. A-Moneim, M.T., "ICEPEL Analysis of and Comparison with Simple Elastic-Plastic Piping Experiments," Rept. ANL-78-105, Argonne Natl. Lab. (Dec 1978).

35. Youngdahl, C.K. and Kot, C.A., "Effect of Plastic Deformation of Piping on Fluid Transient Propagation," Nucl. Engr. Des., 35, pp 315-325 (1975).

36. Youngdahl, C.K., Kot, C.A., and Valentin, R.A., "Pressure Transient Analysis in Piping Systems Including the Effects of Plastic Deformation and Cavitation," ASME Paper 78-PVP-56 (1978).

RECENT ADVANCES IN HELICOPTER VIBRATION CONTROL

G.T.S. Done[1]

***Abstract** - This review describes advances that have been made in the past three years in the control of forced vibration excitation and response of helicopter airframes. Methods and hardware for vibration control, including isolators, absorbers, direct rotor control, and structural modification are considered.*

An earlier review [1] on vibration of helicopters described work through the end of 1975. This earlier review contained a short and simplified account of the ways in which the aerodynamic forces acting on rotor blades provide the main source of vibration to which the fuselage is subjected.

The present review is restricted to airframe forced vibration. Such instability phenomena as ground and air resonance, pitch-lag instability, blade flutter, and tail rotor buzz and bang are not covered. Some of these subjects have been covered briefly by Balmford [2], who deals with all aspects of vibration control and includes descriptions of vibration sources. Gabel [3] has also described the aerodynamic source of vibration and surveyed past and present ways of alleviating forced vibration.

A useful paper that sets the scene for much present and future work is that of Schrage and Peskar [4]; they review current and past vibration requirements and recommend areas for research. The vibration requirements are divided into three categories: human factor considerations, crew and passenger comfort; structural integrity and fatigue damage; and functional adequacy of equipment. Kuczynski [5] and Doman [6] have also published surveys.

A more philosophical paper is that of Hohenemser [7], who examined present methods of helicopter vibration control and suggested procedures to be followed before any one type of control is adopted. Although it is the aerodynamic forces of the rotor that provide the basic oscillatory forcing on the fuselage, a considerable amount of vibration and internally transmitted noise arises from the transmission system, mainly the gears and gearbox. Control of this type of response is different from controlling the vibration arising from the rotor and is not given detailed consideration in this review. However, it should be noted that work in this area has been done [8-11], and it seems likely that an increasing amount will be reported in the future.

Advances over the past three years have been made in techniques for isolating the fuselage from the gearbox and rotorhead; work has also continued steadily in the area of direct rotor control. By comparison, developments in structural modification and absorbers have been relatively sparse. These areas are reviewed below.

VIBRATION ISOLATION

Progress continues on two patented isolation systems, the Kaman DAVI (Dynamic Antiresonant Vibration Isolator) and the Bell Nodalised Beam. Both systems react to the exciting force with inertia forces that derive from the movement of small masses through large displacements via a mechanical linkage [1]. These purely passive devices, which are mounted between the gearbox/rotorhead and the fuselage, provide a stiff suspension system that operates over a wide range of g-values (typically - 0.5g to 3.0g) without bottoming.

Recent research with the DAVI system has been reported from Kaman [12] and Boeing Vertol [13]. The Kaman research shows how several DAVI units can be used to achieve isolation between the gearbox and fuselage for a two-bladed helicopter. Because

[1] *Professor of Applied Mechanics, Department of Mechanical Engineering, The City University, Northampton Square, London EC1V 0HB, England*

the forced frequencies of interest were relatively low (10 Hz for the two per rotor revolution case), an otherwise conventional soft suspension was not practical. The Boeing research involves a system based on DAVI units called IRIS (Improved Rotor Isolation System) with a spring mass beyond the linkage (see Figure 1[2]); the spring mass allows for isolation at two distinct frequencies. The improvement obtained on a four-bladed helicopter is indicated in Figure 2. Both systems provide isolation in three degrees of freedom. Deliberately introduced damping was not beneficial. Vibration levels can generally be kept below 0.05g for most flight conditions.

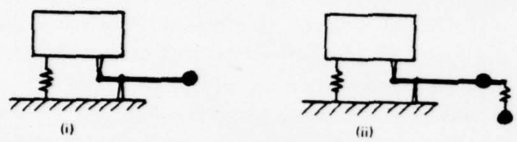


Figure 1. Conventional DAVI (i), and Improved DAVI (ii)

Further applications of the DAVI isolator have been described [15]; the cargo floor of the Chinook, a twin-rotor helicopter, is carried on a series of DAVI units, thus isolating the variable mass cargo that can be carried and effectively preventing it from affecting the fuselage modes. In the same way and for the same reason, the large side fuel tanks are also carried on DAVI isolators. The Bell system has progressed beyond the experimental device stage, and recent experience with it has been described [16-18].

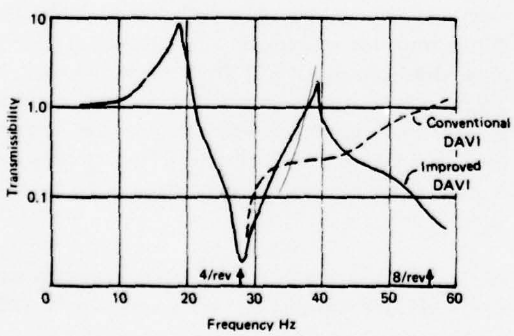


Figure 2. Performance of Improved DAVI

All of the isolation systems mentioned above are passive, but Kuczynski and Madden [19] have described an active one. The platform supporting the transmission is supported on units, which are active in the sense that relative deflection under steady or low frequency load is restored hydraulically to zero. Under high frequency loads the units act as air springs and in this regime behave essentially passively.

DIRECT ROTOR CONTROL

Vibration in the fuselage can be alleviated by controlling the rotor such that the undesired oscillatory forces that usually appear as resultants at the rotorhead are reduced or, ideally, suppressed altogether. Reduction requires an input to each rotor blade at a frequency greater than zero and once per revolution; i.e., that required for maneuver control. The type of input varies according to the method of direct rotor control utilized, but the effect is to cause a greater than once-per-revolution (higher harmonic) variation in the aerodynamic lift forces on the blades.

The use of jet flaps [20] has been described, as has that of servo-flaps [21]. Straightforward pitch control has been used [22-25] via the conventional swash plate. Lemnios and Howes [26] tested a rotor in which both inboard and outboard collective and cyclic controls were used to optimize blade pitch distribution in order to improve vibration levels. In other research, a pre-programmed signal was fed into the rotor [20-23]. Other work [24-28] has been concerned with a fully active system in which information fed back from the rotor is used to control the actuators. In one study [28] there was no swash plate, so the actuators had to perform the normal control functions as well as minimize vibratory forces. The point of the study was that active direct control of the rotor is useful in achieving objectives other than vibration reduction.

ABSORBERS

Rotor-borne pendulum absorbers seem to be out of favor judging from the relative absence of publications, but Murthy and Goglia [29] have made a theoretical study of blade-mounted pendulum absorbers operating normal to the plane of the rotor.

[2] *All figures from "Recent Advances in Helicopter Vibration Control," G.T.S. Done*

An interesting new absorber [30] is in effect a sprung mass mounted on the rotorhead that operates in a plane parallel to the rotor (see Figure 3). An ingenious design of spring using composite materials allows sufficient displacement amplitude but does not endanger fatigue life. The distance of the absorber from the center of mass of the helicopter allows it effectively to counteract the vibratory moment resultants induced at the rotorhead by the aerodynamic loads.

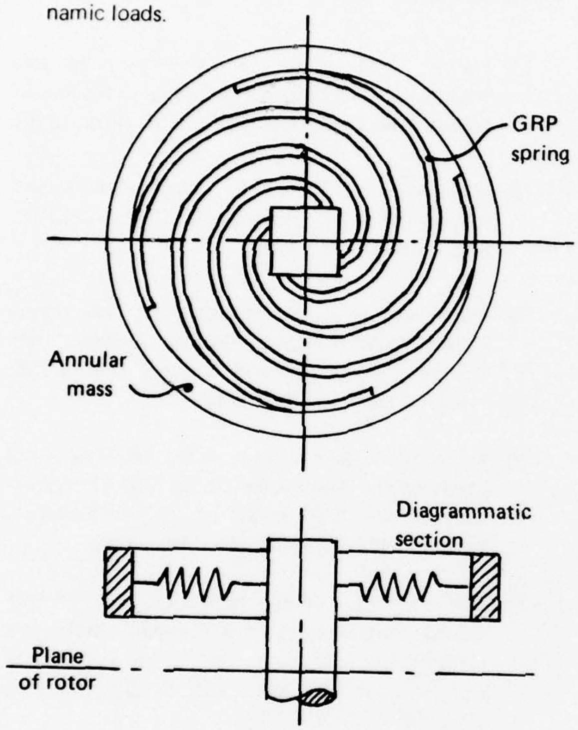


Figure 3. Rotor Head Vibration Absorber

Bartlett [31] has described an approximate method for placing one or more fuselage-mounted absorbers so as to achieve the best effect.

STRUCTURAL MODIFICATION

Structural modification has received very little attention in the helicopter field, although considerable work has been done on fixed-wing aircraft in the area of flutter speed improvement. The reason may be that the problem is less easily defined in helicopters; vibration levels are important at many points in the fuselage, but some are more important than others, with the result that selection of a single objective function is a matter of human judgment. In aircraft flutter, on the other hand, flutter speed is a single parameter and the objective function is simpler. Done [32] and Done and Rangacharyulu [33] have attempted to control structural vibration using modification of the fuselage structure. A standard optimization technique is used on relatively simple structural models.

FUSELAGE VIBRATION ANALYSIS

Knowledge of the response behavior of the fuselage when it is subjected to an oscillatory forcing is important in the problem of vibration alleviation. An analysis of a fuselage structural model using NASTRAN has been described by McLaughlin et al [34]; theoretical normal modes were obtained and forced responses were compared with shake test results. Further development of the work has been published [35].

It is not strictly appropriate to consider the fuselage as an isolated entity excited by forces that derive from the rotor; the dynamic interaction between the rotor and fuselage should be taken into account. The way this can be done without unduly complicating the calculations has been described by Hohenemser and Yin [36], who introduced the impedance of the rotor into the analysis.

REFERENCES

1. Done, G.T.S., "Vibration of Helicopters," Shock Vib. Dig., 9 (1), pp 5-13 (Jan 1977).

2. Balmford, D.E.H., 'The Control of Vibration in Helicopters," Aeronaut. J., 81 (Feb 1977).

3. Gabel, R., 'The Rotorcraft Vibration Problem," Rotorcraft Vibration Workshop, NASA Ames, Moffett Field, CA (Feb 1978).

4. Schrage, D.P. and Peskar, R.E., "Helicopter Vibration Requirements," 33rd Annual Natl. Forum AHS, Washington, D.C. (May 1977).

5. Kuczynski, W.A., "An Assessment of Helicopter Vibration Control Technology," Rotorcraft Vi-

bration Workshop, NASA Ames, Moffett Field, CA (Feb 1978).

6. Doman, G.S., "Research Requirements for the Reduction of Helicopter Vibration," Boeing Vertol Rept. No. D210-11154-1, NASA-CR-145116 (Dec 1976).

7. Hohenemser, K.H., "In Search of Dynamic Design Principles for Suppressing Rotorcraft Vibrations with Blade Passage Frequency," Rotorcraft Vibration Workshop, NASA Ames, Moffett Field, CA (Feb 1978).

8. Bowes, M.A., Giansante, N., Bossler, R.B., Jr., and Berman, A., "Helicopter Transmission Vibration and Noise Reduction Program," Kaman Aerospace Corp. Rept. No. R-1495, USAAMR-DL-TR-77-14 (June 1977).

9. Sciarra, J.J., Howells, R.W., Lenski, J.W., Jr., Drago, R.J., and Schaeffer, E.G., "Helicopter Transmission Vibration and Noise Reduction Program. Vol. I. Technical Report," Boeing Vertol Co. Rept. No. D210-11236-1, USARTL-TR-78-2A (Mar 1978).

10. Sciarra, J.J., Howells, R.W., Lenski, J.W., Jr., and Schaeffer, E.G., "Helicopter Transmission Vibration and Noise Reduction Program. Vol. II. User's Manual," Boeing Vertol Co. Rept. No. D210-11236-2, USARTL-TR-78-2B (Mar 1978).

11. Astridge, D.G. and Salzer, "Modelling Techniques for the Reduction of Noise and Vibration in Gearboxes," Symp. on Internal Noise in Helicopters, Southampton, England (July 1979).

12. Rita, A.D., McGarvey, J.H., and Jones, R., "Helicopter Rotor Isolation Evaluation Utilizing the Dynamic Antiresonant Vibration Isolator," J. Amer. Helicopter Soc., 23 (1), pp 22-29 (Jan 1978).

13. Desjardins, R.A. and Hooper, W.E., "Helicopter Rotor Vibration Isolation," Vertica, 2 (2), pp 145-159 (1978).

14. Desjardins, R.A. and Hooper, W.E., "Antiresonant Rotor Isolation for Vibration Reduction," 34th Natl. Ann. Forum AHS, Washington, D.C. (May 1978).

15. Ellis, C.W., "The Commercial Chinook," Symp. A New Generation of Civil Helicopters, Roy. Aeronaut. Soc., London (Feb 1979).

16. Gaffey, T.M. and Balke, R.W., "Isolation of Rotor Induced Vibration with the Bell Focal Pylon-Nodal Beam System," SAE Aerospace Mtg., San Diego, CA, Paper No. 760892 (Dec 1976).

17. Gaffey, T.M., "Isolation of Rotor Induced Vibration," Rotorcraft Vibration Workshop, NASA Ames, Moffett Field, CA (Feb 1978).

18. Garrison, J.R., "Bell 222," Symp. A New Generation of Civil Helicopters, Roy. Aeronaut. Soc., London (Feb 1979).

19. Kuczynski, W.A. and Madden, J., "The RSRA Active Isolation/Rotor Balance System," 4th European Rotorcraft and Powered Lift Aircraft Forum, Stresa, Italy (Sept 1978).

20. Piziali, R.A. and Trenka, A.R., "A Theoretical Study of the Application of Jet-Flap Circulation Control for Reduction of Rotor Vibratory Forces," NASA CR-137515 (May 1974).

21. McCloud, J.L, III and Weisbrich, A.L., "Wind-tunnel Test Results of a Full-scale Multicycle Controllable Twist Rotor," 34th Ann. Natl. Forum Amer. Helicopter Soc., Washington, D.C. (May 1978).

22. McHugh, F.J. and Shaw, J., "Benefits of Higher Harmonic Blade Pitch: Vibration Reduction, Blade Load Reduction, and Performance Improvement," AHS Mideast Region Symp. Rotor Technology (Aug 1976).

23. McHugh, F.J. and Shaw, J., "Helicopter Vibration Reduction with Higher Harmonic Blade Pitch," 3rd European Rotorcraft and Powered Lift Aircraft Forum, Aix-en-Provence, France (Sept 1977).

24. Hammond, C.E., "Helicopter Vibration Reduction via Higher Harmonic Control," Rotorcraft Vibration Workshop, NASA Ames, Moffett Field, CA (Feb 1978).

25. Wood, E.R., Powers, R.W., and Hammond, C.E., "On Methods for Application of Harmonic Control," 4th European Rotorcraft and Powered Lift Aircraft Forum, Stresa, Italy (Sept 1978).

26. Lemnios, A.Z. and Howes, H.E., "Wind Tunnel Investigation of the Controllable Twist Rotor Performance and Dynamic Behaviour," USA-AMRDL-TR-77-10 (June 1977).

27. Schulz, G., "Design Concepts for a Fully Active Helicopter Vibration Isolation System by Means of Output Vector Feedback," DFVLR Rept. No. DLR-1B-552-76/12 (Sept 1976).

28. Kretz, M., "Relaxation of Rotor Limitations by Feedback Control," 33rd Ann. Natl. Forum Amer. Helicopter Soc., Washington, D.C. (May 1977).

29. Murthy, V.R. and Goglia, G.L., "Dynamic Characteristics of Rotor Blades with Pendulum Absorbers," NASA-CR-153929 (July 1977).

30. White, R.W., "A Fixed Frequency Rotor Head Vibration Absorber Based Upon G.F.R.P. Springs," 5th European Rotorcraft and Powered Lift Aircraft Forum, Amsterdam, The Netherlands (Sept 1979).

31. Bartlett, F.D., Jr., "Techniques for Vibration Design: Remote Absorbers," Rotorcraft Vibration Workshop, NASA Ames, Moffett Field, CA (Feb 1978).

32. Done, G.T.S., "Control of Fuselage Vibration by Passive Means," Rotorcraft Vibration Workshop, NASA Ames, Moffett Field, CA (Feb 1978).

33. Done, G.T.S. and Rangacharyulu, M.A.V., "Use of Optimization in Helicopter Vibration Control by Structural Modification," 5th European Rotorcraft and Powered Lift Aircraft Forum, Amsterdam, The Netherlands (Sept 1979).

34. McLaughlin, A., Venn, G.M., and Barnard, A.J., "A Vibration Study of the Lynx Airframe Using the Finite Element Method," 3rd European Rotorcraft and Powered Lift Aircraft Forum, Aix-en-Provence, France (Sept 1977).

35. McLaughlin, A., "Finite Element Dynamic Analysis of Production Aircraft," 4th European Rotorcraft and Powered Lift Aircraft Forum, Stresa, Italy (Sept 1978).

36. Hohenemser, K.H. and Yin, S.K., "The Role of Rotor Impedance in the Vibration Analysis of Rotorcraft," 4th European Rotorcraft and Powered Lift Aircraft Forum, Stresa, Italy (Sept 1978).

BOOK REVIEWS

DYNAMIQUE DES FONDATIONS DE MACHINES

G. Buzdugan
Editions Eyrolles, 61, boulevard Saint-Germain, Paris, 1972
Translated into French by E. Geles from The 1968 Roumanian edition Dinamica Fundatiilor De Masini

Dynamique des Fondations de Machines, by G. Buzdugan is a detailed account of standard analysis for problems encountered in industrial machine design. A loose translation of the title is Dynamics of Machine Supports. Throughout the book machines and their supports are idealized as damped, spring-mass systems that interact with foundations ranging from soils to elastic platforms. Both free and periodically driven vibrations are considered.

The author develops his analysis from the basic equations of mechanics, but his primary interest is the accurate modeling of specific industrial environments. The book is not an abstract mathematical analysis of generalized vibrations problems, nor is it written as a textbook suitable for an introductory structural vibrations course. The large amount of practical detail in the book could easily obscure fundamental ideas of structural vibrations for an engineer not already familiar with the subject. The book is, on the other hand, a good handbook of machine design practice; it would make an appropriate reference volume in a machine design course.

Certain specific problem areas are treated in great detail. The coverage of the elastic and damping properties of soil is particularly noteworthy, as this material is not usually included in vibrations texts. Topics covered include soil interaction with pilings, nonlinearities inherent to soil mechanics, and the effect of machine vibrations on the soil itself. Other material particularly useful as a supplement to standard texts is found in the chapter concerned with acceptable vibration limits for machines and supports. Harmful effects of vibrations are divided into three categories: men, buildings, and equipment. Acceleration and displacement responses of specified degrees of acceptability are published as functions of frequency. A chapter on "Experimental Methods in Support Vibration Studies" treats primarily the experimental determinations of elastic and damping coefficients, but it also describes the experimental verification of various predictions of vibration theory. Other chapters cover special considerations for rod-crank devices, turbine machinery, and the shock isolation of impacting machinery.

The book is a well organized account of the standard design practice for solving industrial machinery vibration problems.

P.J. Torvik and J.R. Shea, III
Department of Mechanics and Engineering Systems
Department of the Air Force
Air Force Institute of Technology
Wright-Patterson AFB, Ohio 45433

SYSTEM DYNAMICS

K. Ogata
Prentice-Hall, Englewood Cliffs, New Jersey, 1978

This book is intended to serve as an introductory text in linear systems, oriented more heavily toward mechanical engineering systems problems. A great deal of emphasis is placed upon mathematical modeling process of physical systems and, as a result, the system analysis part of the text is more restrictive than what is contained in more standard introductory texts in linear systems.

The portion on mathematical modeling occupies more than half the text which covers modeling problems in mechanical, electrical, hydraulic, and pneumatic systems. It is well written, and, in this reviewer's opinion, provides a good motivation for studying the mathematical problems so introduced. This is further strengthened by including in these chapters a large number of carefully chosen examples. On the other hand, probably because of the one-semester limitation, the analysis part is given less than adequate coverage. Fourier methods, for example, are not discussed. The use of digital computers, which has become indispensable in systems analysis and simulation, also lacks exposure.

It is, in this reviewer's opinion, a good text for an undergraduate introductory course in systems, provided that it is not a terminal course. A follow-up course in more advanced analysis techniques is necessary in order that the student can have a reasonable mastery over the subject area.

T.T. Soong
Department of Civil Engineering
State University of New York at Buffalo
Buffalo, New York 14214

MECHANICS OF COMPOSITE MATERIALS

R.M. Jones
McGraw-Hill Book Co., New York, 1975

Composite materials have become of considerable interest over the past two decades because of the need for materials having different properties -- high strength and stiffness to weight ratios -- from those provided by natural materials. Mechanics of Composite Materials is an introductory graduate level text. It is well organized, readable, easily understood, and excellent as both a textbook and for self study. An introductory chapter contains a general description of composite materials. The balance of the book deals primarily with laminated materials.

Strength of materials and the theories of elasticity and failure are applied to the development of the elastic and strength properties of a single isotropic, orthotropic, or anisotropic lamina; the properties of aggregates of laminae -- i.e., laminates -- are then developed. Mathematical material is presented as required and applied to the development of the text; less essential but important details are presented in appendices. Bending, buckling, and vibration of laminated plates are described.

The references indicate that the book, which was published in 1975, is a state of the art about 1970. The book should be useful not only to students and teachers but also to engineers entering the field.

A.O. Sykes
Department of the Navy
Office of Naval Research
Arlington, Virginia 22217

SHORT COURSES

JANUARY

PROBABILISTIC AND STATISTICAL METHODS IN MECHANICAL AND STRUCTURAL DESIGN

Dates: January 7-11, 1980
Place: Tucson, Arizona
Objective: To provide practical information on engineering applications of probabilistic and statistical methods, and design under random vibration environments. Modern methods of structural and mechanical reliability analysis will be presented. Special emphasis will be given to fatigue and fracture reliability.

Contact: Dr. Paul H. Wirsching, College of Engineering, The University of Arizona, Tucson, AZ 85721 - (602) 626-3159/626-3054.

FINITE ELEMENT ANALYSIS

Dates: January 7-11, 1980
Place: Tucson, Arizona
Objective: The purpose of this course is to provide structural engineering practitioners with an understanding of the fundamental principles of finite element analysis, to describe applications of the method, and to present guidelines for the proper use of the method and interpretation of the results obtained through it. Emphasis will be placed upon the linear analysis of frameworks, plates, shells and solids; and dynamic analysis will also be treated.

Contact: Dr. Hussein Kamel, College of Engineering, The University of Arizona, Tucson, AZ 85721 - (602) 626-1650/626-3054.

MODAL ANALYSIS

Dates: January 8-10, 1980
Place: San Diego, California
Dates: September 17-19, 1980
Place: Cleveland, Ohio
Objective: This seminar will provide information on new techniques for identifying dynamic structural weaknesses. The sessions include the use of state-of-the-art instrumentation and software for creating a dynamic structural model in the computer. Techniques will be demonstrated for mode shape calculation and animated displays, computation of mass, stiffness and damping values and modal manipulation methods.

Contact: Bob Kiefer, Spectral Dynamics, P.O. Box 671, San Diego, CA 92112 - (714) 268-7100.

DYNAMIC ANALYSIS IN TURBOMACHINERY DESIGN

Dates: January 14-18, 1980
Place: Madison, Wisconsin
Objective: This course will be devoted to the understanding of mechanical phenomena involved in turbomachinery design, including torsional and lateral shaft vibrations and vibrations of components such as rotating fan and turbine blades and non-rotating vanes. Topics to be covered include lumped parameter analysis of rotors in rigid and flexible bearings, internal and external damping, effects of coupled transverse and angular motion; lumped parameter and normal mode analysis of blade response allowing for effects of damping, hysteresis loop characteristics, slip at dovetails and at platforms; and vibrations of stationary vanes. Some state of the art experimental techniques will be discussed.

Contact: Dr. Donald E. Baxa, Dept. of Engineering, University of Wisconsin - Extension, 432 N. Lake St., Madison, WI 53706 - (608) 262-2061.

VIBRATION TESTING

Dates: January 21-24, 1980
Place: San Diego, California
Dates: October 6-9, 1980
Place: San Diego, California
Objective: Topics to be covered are: exciters, fixtures, transducers, test specifications and the latest computerized techniques for equalization, control,

and protection. Subjects covered include dynamics and dynamic measurements of mechanical systems, vibration and shock specifications and data generation. Demonstrations are given of sine random and shock testing and of how test specifications are met.

Contact: Bob Kiefer, Spectral Dynamics, P.O. Box 671, San Diego, CA 92112 - (714) 268-7100.

STRUCTURAL ANALYSIS & TESTING

Dates: January 21-25, 1980
Place: Reno, Nevada
Objective: This course deals with the latest theory on the role of modal, finite element, and sub-structuring techniques in product design and trouble-shooting. The modularized concept of course presentation permits the attendee to structure the curriculum specifically to his needs.

Contact: Onstead & Associates, Inc., 1333 Lawrence Expressway, Bldg. 100, Suite 103, Santa Clara, CA 95051 - (408) 246-7656.

FEBRUARY

VIBRATION AND SHOCK SURVIVABILITY, TESTING, MEASUREMENT, ANALYSIS, AND CALIBRATION

Dates: February 4-8, 1980
Place: Santa Barbara, California
Dates: April 7-11, 1980
Place: Dayton, Ohio
Objective: Topics to be covered are resonance and fragility phenomena, and environmental vibration and shock measurement and analysis, also vibration and shock environmental testing to prove survivability. This course will concentrate upon equipments and techniques, rather than upon mathematics and theory.

Contact: Wayne Tustin, 22 East Los Olivos St., Santa Barbara, CA 93105 - (815) 682-7171.

FIXTURE DESIGN FOR VIBRATION AND SHOCK TESTING

Dates: February 11-15, 1980
Place: Santa Barbara, California
Dates: March 10-14, 1980
Place: St. Petersburg, Florida
Objective: The relative merits of various types of shakers and shock test machines are briefly considered, with most emphasis on electromagnetic shakers. The seminar will be devoted to practical and proven simplified design and fabrication techniques. An important area to be covered is that of evaluating a fixture once it is built.

Contact: Wayne Tustin, Tustin Institute of Technology, 22 East Los Olivos St., Santa Barbara, CA 93105 - (815) 682-7171.

MACHINERY VIBRATION ANALYSIS

Dates: February 12-14, 1980
Place: San Diego, California
Dates: April 9-11, 1980
Place: Chicago, Illinois
Dates: June 18-20, 1980
Place: Houston, Texas
Dates: August 26-28, 1980
Place: Las Vegas, Nevada
Dates: December 10-12, 1980
Place: New Orleans, Louisiana
Objective: The course covers causes, effects, detection, and solutions of problems relating to rotating machines. Vibration sources, such as oil and resonant whirl, beats, assembly errors, rotor flexibility, whip, damping, eccentricity, etc. will be discussed. The effect on the overall vibration level due to the interaction of a machine's structure, foundation, and components will be illustrated.

Contact: Bob Kiefer, Spectral Dynamics, P.O. Box 671, San Diego, CA 92112 - (714) 268-7100.

FINITE ELEMENTS IN BIOMECHANICS

Dates: February 18-21, 1980
Place: Tucson, Arizona
Objective: As a forum for the exchange of ideas, for the definition of the state-of-the-art, and for the presentation of new research results in biomechanics.

Contact: Professor Bruce R. Simon, Dept. of Aerospace and Mechanical Engineering, College of Engineering, The University of Arizona, Tucson, AZ 85721 - (602) 616-3752/626-3054.

BALANCING OF ROTATING MACHINERY
Dates: February 26-28, 1980
Place: Shamrock Hilton, Houston, Texas
Objective: The seminar will emphasize the practical aspects of balancing in the shop and in the field. The instrumentation, techniques, and equipment pertinent to balancing will be elaborated with case histories. Demonstrations of techniques with appropriate instrumentation and equipment are scheduled. Specific topics include: basic balancing techniques (one-and two-plane), field balancing, balancing without phase measurement, balancing machines, use of programmable calculators, balancing sensitivity, flexible rotor balancing, and effect of residual shaft bow on unbalance.

Contact: Dr. Ronald L. Eshleman, Vibration Institute, 101 W. 55th St., Suite 206, Clarendon Hills, IL 60514 - (312) 654-2254/654-2053.

MARCH

MEASUREMENT SYSTEMS ENGINEERING
Dates: March 10-14, 1980
Place: Phoenix, Arizona

MEASUREMENT SYSTEMS DYNAMICS
Dates: March 17-21, 1980
Place: Phoenix, Arizona
Objective: Program emphasis is on how to increase productivity, cost-effectiveness and data-validity of data acquisition groups in the field and in the laboratory. Emphasis is also on electrical measurements of mechanical and thermal quantities.

Contact: Peter K. Stein, 5602 East Monte Rosa, Phoenix, AZ 85018 - (602) 945-4603/946-7333.

DIGITAL SIGNAL PROCESSING
Dates: March 11-13, 1980
Place: San Diego, California
Dates: October 21-23, 1980
Place: Atlanta, Georgia
Objective: The mathematical basis for the fast Fourier transform calculation is presented, including frequency response, impulse response, transfer functions, mode shapes and optimized signal detection. Convolution, correlation functions and probability characteristics are described mathematically and each in demonstrated on the Digital Signal Processor. Other demonstrations include spectrum and power spectrum measurements; relative phase measurements between two signals; and signal source isolation.

Contact: Bob Kiefer, Spectral Dynamics, P.O. Box 671, San Diego, CA 92112 - (714) 268-7100.

MACHINERY VIBRATIONS COURSE
Dates: March 17-20, 1980
Place: Oakbrook Hyatt House, Oakbrook, IL
Objective: This course on machinery vibrations will cover physical/mathematical descriptions, calculations, modeling, measuring, and analysis. Machinery vibrations control techniques, balancing, isolation, and damping, will be discussed. Techniques for machine fault diagnosis and correction will be reviewed along with examples and case histories. Torsional vibration measurement and calculation will be covered.

Contact: Dr. Ronald L. Eshleman, Vibration Institute, 101 W. 55th St., Suite 206, Clarendon Hills, IL 60514 - (312) 654-2254/654-2053.

BOUNDARY INTEGRAL EQUATION METHODS
Dates: March 17-22, 1980
Place: University of Arizona, Computer Center
Objective: The objective of this short course is to introduce the Boundary Integral Equation Method (BIEM) as an efficient numerical tool for the solution of various types of ground-water problems. The course is designed to provide a working knowledge of the BIEM so that the participants will be able to use and modify the existing computer programs and to develop their own programs for their specific problems.

Contact: Professor James A. Liggett or Professor Phillip L.-F. Liu, School of Civil and Environmental Engrg., Cornell University, Hollister Hall, Ithaca, NY 14853 - (607) 256-3556/256-5090 respectively.

EXPLOSION HAZARDS EVALUATION
Dates: March 31-April 4, 1980
Place: Southwest Research Institute
Objective: This course covers the full spectrum of problems encountered in assessing the hazards of accidental explosions, in designing the proper con-

tainment as necessary, as well as developing techniques to reduce incidence of accidents during normal plant and transport operations. Specific topics to be covered are: fundamentals of combustion and transition to explosion; free-field explosions and their characteristics; loading from blast waves; structural response to blast and non-penetrating impact; fragmentation and missile effects; thermal effects; damage criteria; and design for blast and impact resistance.

Contact: Wilfred E. Baker, Southwest Research Institute, P.O. Drawer 28510, San Antonio, TX 78284 - (512) 684-5111, Ext. 2303.

APRIL

ACOUSTICS AND NOISE CONTROL

Dates: April 14-18, 1980

Place: The University of Tennessee Space Inst.

Objective: This is an introductory course dealing with the fundamentals of vibration and noise control. The equations governing the vibrations of continuous systems and sound propagation will be developed and certain elementary solutions derived to illustrate the basic characteristics of the wave motion. Sound propagation in the atmosphere, acoustic filters and resonators, and the attenuation of sound in rooms and ducts by acoustic treatment will be discussed. Fundamental measurement techniques and statistical parameters applicable to the description of noise will be presented.

Contact: Jules Bernard, The Univ. of Tennessee Space Institute, Tullahoma, TN 37388 - (615) 455-0631, Ext. 276.

APPLICATIONS OF TIME SERIES ANALYSIS

Dates: April 14-18, 1980

Place: Institute of Sound and Vibration Research, University of Southampton, UK

Objective: To provide a comprehensive treatment of time and frequency domain analysis methods for transient and stationary random signals summarizing essential theory and giving engineering applications. To present theories and some applications related to non-stationary processes, system identification and response of non-linear systems to stochastic excitation. To apply the theory to well conceived practical problems utilizing the computers in the Data Analysis Centre enabling participants to experience how new methods may be related to present day industrial requirements.

Contact: Dr. Joseph K. Hammond, Institute of Sound and Vibration Research, University of Southampton, Southampton, Hampshire, England, S09 5NH - 559122, Ext. 467.

JUNE

MACHINERY VIBRATIONS SEMINAR

Dates: June 24-26, 1980

Place: Mechanical Technology, Inc.
Latham, New York

Objective: To cover the basic aspects of rotor-bearing system dynamics. The course will provide a fundamental understanding of rotating machinery vibrations; an awareness of available tools and techniques for the analysis and diagnosis of rotor vibration problems; and an appreciation of how these techniques are applied to correct vibration problems. Technical personnel who will benefit most from this course are those concerned with the rotor dynamics evaluation of motors, pumps, turbines, compressors, gearing, shafting, couplings, and similar mechanical equipment. The attendee should possess an engineering degree with some understanding of mechanics of materials and vibration theory. Appropriate job functions include machinery designers; and plant, manufacturing, or service engineers.

Contact: Mr. Paul Babson, MTI, 968 Albany-Shaker Rd., Latham, NY 12110 - (518) 785-2371.

NEWS BRIEFS news on current and Future Shock and Vibration activities and events

Institute of Environmental Sciences
Elects
Dr. Charles Tabor Morrow Fellow

Dr. Charles Tabor Morrow was elected to the membership grade of FELLOW in the Institute of Environmental Sciences. Dr. Morrow was honored "for his original contributions to the science of random vibration and shock analysis and testing, and for his continued work leading to improved underwater diver communications."

Dr. Morrow has authored many papers in the field of random vibration testing. He is considered one of the persons primarily responsible for the introduction and development of random vibration testing. He has done outstanding work in the field of shock and spectrum technology. Dr. Morrow is listed in the American Men of Science. He is a graduate of Harvard College and Harvard Engineering School, receiving his Doctor of Science at Harvard Engineering School. Dr. Morrow is an independent consultant.

Dr. Morrow has served on the Institute of Environmental Sciences' Acoustics and Shock and Vibrations Committees. He has presented technical papers at IES Annual Meetings and conducted tutorial lecture series at these meetings.

The fellow award was presented to Dr. Morrow by Robert N. Hancock, President of the Institute of Environmental Sciences, at the Shock and Vibration Symposium in Colorado Springs, CO, October 16, 1979.

For further information please contact:

Betty L. Peterson, Executive Director
Institute of Environmental Sciences
940 East Northwest Highway
Mt. Prospect, Illinois 60056
(312) 255-1561

Institute of Environmental Sciences
26th Annual Technical Meeting and Equipment Exposition

The Institute of Environmental Sciences will hold its 26th Annual Technical Meeting and Equipment Exposition, May 11-14, 1980, at the Marriott Hotel, Philadelphia, PA.

"Life Cycle Problems and Environmental Technology," Bringing Environmental Interrelationships to Bear on Life Cycle Considerations, is the theme of this meeting. The theme has significance for a diverse variety of technical disciplines. For hardware and equipment, life cycles have become the period of time over which ownership costs are calculated. Life cycle profits describe the complete range of stress conditions to which a product or piece of equipment will be subjected. For the ecologist, a life cycle may reflect the complex interrelationship of many biological phenomena or the restoration time of a perturbed ecosystem.

Regardless of which life cycle problems are considered, one fact remains equally relevant; life cycle problems can be solved only by the carefully coordinated integration of many individual technical disciplines. No one technical discipline can stand alone. There is, then a dual nature to the information that can be collected and analyzed in the environmental sciences.

The IES recognizes this dual nature of technical information in the structure and content of its 1980 Annual Technical Meeting.

Henry Caruso, Westinghouse Electric Corporation, is the Technical Program Chairman of this meeting. Henry C. Pusey, Shock and Vibration Information Center, Naval Research Labs, is General Chairman.

The technical program will be presented in seven in-depth seminars on key life cycle issues. They are:

I. The Critical Need for Environmental Integration: Specification, Design and Test

- *Myths and Sacred Cows in Environmental Design and Test
- *Test Engineers Liability
- *Environmental Integration: Design and Test
- *New Specifications and Standards
- *Combined Environment Test Utility
- *Environmental Stress Screening

II. The Challenge of Environmental Test Tailoring For Electronic Hardware

- *Myths and Sacred Cows in Environmental Design and Test
- *Test Tailoring Approaches
- *Practical Environmental Reliability Modeling
- *Clynamics (Dynamic Climatic Conditions)
- *Microenvironments
- *Low-Cost Vibration Alternatives
- *Combined Environment Test Utility
- *Environmental Stress Screening

III. Emerging Technology in Environmental Testing and Measurement

- *Myths and Sacred Cows in Environmental Design and Test
- *Electromagnetic Compatibility
- *Acoustics Testing/Industrial Acoustics
- *New Shock Test Approaches
- *Shock/Vibration Test Fixturing
- *Instrumentation, Digital Processing and Control
- *Technical Information Resources

IV. The Growing Conflict Between Energy Demands and Environmental Regulation

- *Solar Energy Effects/Implementation
- *Alternative Energy Sources: Practicality and Environmental Consequences
- *Energy Conservation and the Environment
- *Siting of Energy Facilities: Environmental and Management Issues
- *Nuclear Energy Environmental Consequences
- *Energy Effects Assessment and Environmental Management

V. Environmental Strategy and Economic Balance: Planning and Management to Cope with Today's Environment Regulation

- *State Implementation Plans
- *Resources Conservation and Recovery Act (RCRA): Hazardous and Toxic Materials
- *Water Pollution
- *Coastal Zone Environmental and Planning Issues
- *Land Use Environmental Planning and Management
- *Urban Planning Management and the Environment
- *Energy Effects Assessment and Environmental Management

VI. Contamination Control: Past Myths and Future Problems

- *Realism in Contamination Control
- *Aerospace Applications
- *Microcircuit Concerns
- *Medical Problems
- *Pharmaceutical Requirements
- *Industrial/Scientific Community Concerns

VII. Environmental Education and Training

- *Bridging the Industry-University Gap
- *Cross-Training/Management Training in Construction Projects
- *Student Views on Environmental Science

Reinforcing the seminar program will be a 3-day equipment exposition presenting the latest available technology in environmental test, monitoring, and control equipment. Hands-on Exhibits will provide a unique opportunity for participants to evaluate the following types of equipment:

- *Digital control, monitoring, and data processing
- *Environmental test facilities (climatics, dynamics combined environments)
- *Pollution monitoring and assessment
- *Contamination detection and control
- *Environmental measurement sensors

To reserve exhibit space contact:

Norman Ponge, IES Exhibits Chairman
Space-Tronics, Inc.
1850 Landsdowne Avenue
North Merrick, L.I., NY 11566

For further information please contact:

Betty L. Peterson, Executive Director
Institute of Environmental Sciences
940 East Northwest Highway
Mt. Prospect, Illinois 60056
(312) 255-1561

Institute of Sound and Vibration Research

Call for Papers

The Institute of Sound and Vibration Research announces a call for papers for an International Conference on "Recent Advances in Structural Dynamics," to be held at Southampton University, July 7-11, 1980.

Accepted papers of up to fifteen pages will be required by 1 March 1980, for publication in the Conference Proceedings.

Sessions are planned for such topics as: developments in theoretical methods and testing techniques; correlation of theory with experiment; structure-fluid interaction; composite structures; wave propagation; machinery vibration; and dynamic stability.

The following speakers have accepted invitations: L. Meirovitch, E.H. Dowell, C.W. Bert, M. Heckl, D.J. Ewins, A.D.S. Barr, and M.G. Hallam.

Abstracts and requests for further information should be sent to:

Dr. M. Petyt
Institute of Sound and Vibration Research
The University
Southampton S09 5NH
England

11th Space Simulation Conference

Call for Papers

The 11th Space Simulation Conference will be held September 23-25, 1980 at the Lyndon B. Johnson Space Center in Houston, Texas. The conference will be hosted by the Institute of Environmental Sciences (IES) and supported by the American Institute of Aeronautics and Astronautics (AIAA), American Society for Testing and Materials (ASTM), and National Aeronautics and Space Administration (NASA) through mutual interests in technical activities in the subject area.

The purpose of the conference is to provide a forum for the review and exchange of information and ideas on current space simulation technology and closely related disciplines as well as projections for testing requirements and technology development for the 1980s.

Papers are being solicited in the following subject areas: space simulation facilities; spacecraft testing; thermal protection; space program trends; unique facilities; remote sensing; life sciences; space physics; vacuum/cyrogenics; contamination experiments; contamination equipment; and thermal simulation.

Papers dealing with subjects other than those listed above will be considered for the conference based on their relatedness to these subject areas. Papers for presentation will be selected on the basis of abstracts of approximately 500 words. The abstract should include the description and principal results of the investigation as well as status and extent of the work.

To assure proper consideration of a paper, three copies of the abstract must be submitted before January 15, 1980 to the Technical Program Chairman: George F. Wright, Jr., Division 5633, Sandia Laboratories, P.O. Box 5800, Albuquerque, NM 87185.

An accompanying cover letter should provide the complete paper title, the author's name and affiliation, address and phone number. All papers must be unclassified and not previously published.

Authors will be notified of the Program Committee's decision by March 1, 1980. The photo-ready manuscripts of accepted papers will be required no later than June 30, 1980 in order to be included in the publication of the conference proceedings.

Noise and Vibration Control Conference

NOISEXPO '80, the National Noise and Vibration Control Conference and Exhibition, will be presented April 28 - May 1, 1980 at the Hyatt Regency O'Hare.

The conference program features a unique series of mini-courses on noise and vibration related topics at presentation levels from basic to advanced.

NOISEXPO registrants may select from one to eight course units specifically tailored to their own information needs. The conference program also includes technical sessions featuring papers on: industrial noise and vibration, instrumentation and measurements, environmental noise, product noise and vibration, architectural acoustics, and hearing conservation.

NOISEXPO '80 serves individuals who are concerned with noise and vibration control and related topics. Engineers, technicians and managers from industry; personnel from governmental agencies; educators; and researchers will benefit from the program.

The NOISEXPO '80 exhibition features instrumentation for noise and vibration measurement, products for noise and vibration control, and equipment for hearing conservation programs.

Registration information is available from:

NOISEXPO
27101 East Oviatt Road
Bay Village, Ohio 44140
(216) 835-0101

51st Shock and Vibration Symposium Meeting Announcement

The 51st Shock and Vibration Symposium will be held on October 21-23, 1980, at the Holiday Inn at the Embarcadero, San Diego, California. The U.S. Navy will be the host. For further information, contact:

Henry C. Pusey
Director
The Shock and Vibration Information Center
Code 8404
Naval Research Laboratory
Washington, D.C. 20375
(202) 767-3306

REVIEWS OF MEETINGS

SYMPOSIUM ON PRACTICAL EXPERIENCES WITH FLOW-INDUCED VIBRATIONS

Karlsruhe, Germany, September 3-6, 1979

Reviewed by D.W. Sallet
Department of Mechanical Engineering
The University of Maryland
College Park, MD 20742

The international symposium entitled "Practical Experiences with Flow-Induced Vibrations" was held at the University of Karlsruhe in Germany from September 3 to 6, 1979. The symposium was sponsored jointly by the International Association for Hydraulic Research (IAHR) and the International Union of Theoretical and Applied Mechanics (IUTAM). The meeting was a follow-up to the 1972 IUTAM/IAHR Symposium held also in Karlsruhe* The 1972 Symposium focused on recent research and the development of new methods and solutions pertaining to flow-induced structural vibrations; the objective of the 1979 Symposium was more praxis oriented. According to the organizers of the 1979 Symposium: "a major objective is to stimulate interaction between field engineers, design engineers and researchers from a variety of disciplines. The goals are to provide engineers with an overview of possible vibration problems and of effective cures, to supply engineers and scientists with research priorities, and to contribute ultimately, to improved design criteria."

The stated objective of the symposium was fully realized. The mixture of contributions from such research-oriented institutions as universities and from diverse industries was very well chosen to meet the goals of the symposium: 64 percent of the contributions came from industry. Seven technical sessions treated flow-induced vibrations in the following engineering fields: reactor and heat-exchanger components; ocean structures; hydraulic machinery and equipment; bridge decks, beams and cables; high-rise buildings and structures; hydraulic structures; and ship structures. Most technical sessions began with an extensive general lecture that surveyed the field; these were followed by invited papers and general contributions. Ample time was allotted for discussion of the lectures and the presented papers. None of the presentations or sessions was held simultaneously; participants were thereby able to hear all speakers. A complete listing of papers is given at the end of this review.

In addition to the formal presentations of papers, the symposium provided opportunities for the exchange of ideas in an informal workshop, a film session with an open discussion of case histories, model investigations and methods of prediction, and a concluding panel discussion. Both the workshop and the panel discussion were preceded by either introductory papers or statements summarizing the state of the art and the most important problems remaining to be solved. The workshop, entitled "Prediction and Modelling of Flow-Induced Vibrations," concentrated on structural response to incident turbulence, simulation using discrete vortices, and nonlinear oscillator modelling of vortex-induced and galloping vibrations. The concluding panel discussion centered on unresolved problems, the shortcomings of design criteria that became evident during the symposium, and the need for future efforts in research, development, and design.

The chairmen of the symposium, Professor E. Naudascher of the University of Karlsruhe and Professor D.O. Rockwell of Lehigh University in the U.S. as well as the local organizing committee under the direction of Dr. R. Ermshaus are to be congratulated for arranging a most meaningful and superbly organized international symposium, attended by participants from 25 nations representing all continents. The outstanding features of the symposium were the exemplary interaction between practicing engineers and researchers, the importance and relevance of the discussed problems in their respective fields of specialty, the emphasis on a solutions-oriented approach, and the candor with which un-

**See review in The Shock and Vibration Digest, 5 (1), pp 15-19 (1973)* solved problems were discussed. A complete set of bound preprints was available at the start of the conference. All contributions, including the general lectures and summaries of the workshop and panel discussion will be published by Springer Verlag; the book is scheduled to available in April 1980. For the convenience of the reader a complete list of papers is given below. It is suggested that queries for copies of preprints of individual papers be directed to the authors.

TECHNICAL SESSION A:
"Reactor and Heat-Exchanger Components"

General Lecture: "Flow-Induced Vibrations in Nuclear Reactor and Heat Exchangers," M. Paidoussis, McGill University, Canada

1. "Heat-Exchanger Tube Vibration: Comparison between Operating Experiences and Vibration Analyses," (invited paper), M.J. Pettigrew, A.O. Campagna, Atomic Energy of Canada

2. "Tube Vibrations in Large Condensers," D. Bai, Electricité de France, France

3. "Vibration of Reactor System Components: Heat-Exchanger Tubes, Flow Collector, and Thermowell," H. Halle, T.M. Mulcahy, M.W. Wambsganss, Argonne National Laboratory, USA

4. "Excitation, Amplification and Suppression of Flow-Induced Vibrations in Heat-Exchangers," M.M. Zdravkovich, University of Salford, UK and J.E. Namork, Det Norski Veritas, Norway

5. "Response of a Tube Bank to Crossflow-Induced Excitation at Trans and Supercritical Reynolds Numbers," B.T. Lubin, H.N. Guerrero, R.C. Kantayya, C-E Power Systems, Combustion Engineering Inc., USA

6. "Design Criteria for Flow-Induced Vibration in Heat-Exchangers," W.B. Bryce, B.G. Murray, Babcock & Wilcox Ltd., UK

7. "Flow-Induced Vibration Problems in the Dungeness B and Windscale Advanced Gas Cooled Reactors," M.W. Parkin, Atomic Energy Authority, UK

8. "Flow-Induced Pendulum Oscillations," K. Henning, E. Platen, DDR Academy of Sciences, D.R. Germany

9. "Main Steam Piping Vibration Driven by Flow-Acoustic Excitation," (invited paper), R.T. Hartlen, W. Jaster, Ontario Hydro Research Division, Canada

10. "Flutter of Plates and Shells in Practice," (invited paper), E.H. Dowell, Princeton University, USA

11. "Flow-Induced Vibration in Oil-Refinery Piping,' M.A. Hassouneh, Kuwait National Petroleum Co., Kuwait

12. "The Flow-Induced Response of Reactor Pressure Vessel Thermal Insulation," M.E. Drake, A.G. Watson, P.N. Whitton, Berkeley Nuclear Laboratories, UK

13. "Core Barrel Oscillations during Blowdown of a Pressurized Water Reactor," U. Schumann, Kernforschungszentrum Karlsruhe, F.R. Germany

TECHNICAL SESSION B:
"Ocean Structures"

General Lecture: "Dynamics of Offshore Structures: Problems, Solutions and Benefits," L.R. Wootton, Atkins Research & Development, UK

1. "Some Hydrodynamic Characteristics of the Wave-Induced Vibration of Offshore Structures," (invited paper), T.L. Shaw, University of Bristol, UK

2. "Current-Induced Oscillations of Cognac Piles During Installation - Prediction and Measurement," E.J. Fischer, W.T. Jones, Shell Development Company, USA and R. King, British Hydromechanics Research Association, UK

3. "Transverse Motion of a Buoy by Surface Waves," K. Ogihara, Tokyo University, Japan

4. "The Suppression of Flow-Induced Motions of a Submerged Moored Cylinder by Means of Spoilers and Splitter Plates," D.W. Sallet, University of Maryland, USA

TECHNICAL SESSION C:
"Hydraulic Machinery and Equipment"

1. "Some TVA Experiences with Flow-Induced Vibrations," (invited paper), P.A. March, S. Vigander, Tennessee Valley Authority, USA

2. "Hydroturbine Rotor Vibration," D.N. Gorelov, V.A. Kovalenko, V.M. Malyshe, S.N. Yavits, All-Union Research Institute of Hydrotechnics (VNIGG), USSR

3. "Vibration Phenomena on Hydraulic Axial Turbines," O. Eichler, Voith GmbH, F.R. Germany

4. "Dynamic Stresses on Stay Vanes of Vertical-Shaft Large-Size Francis Turbines," H. Kirchner, Voith GmbH, F.R. Germany

5. "Aerodynamic Blade Excitation in Turbocompressors," R.J. Jenny, U. Bolleter, Sulzer Brothers Ltd., Switzerland

6. "Pressure Surge in the Draft Tube of Francis Turbine," T. Kubota, H. Aoki, Fuji Electric Co. Ltd., Japan

7. "Vibrational Problems with Mixed-Flow Pumps," R.A. Elder, Bechtel Inc., USA

8. "Swirling Flow-Induced Vibrations in Turbomachine Exit Chambers," M.P. Escudier, Brown, Boveri & Co., Ltd., Switzerland

9. "A Case of Self-Excited Oscillations in a Hydroelectric Unit," A.H. Glattfelder, H. Grein, L. Huser, Escher Wyss Ltd., Switzerland

10. "Reduction of Vibrations in a Centrifugal Pump Hydraulic System," Y.N. Chen, D. Florjancic, R. Stürchler, Sulzer Brothers Ltd., Switzerland

11. "Flow-Induced Vibrations in Valves Operating at Small Openings," (invited paper), D.S. Weaver, McMaster University, Canada

12. "Governing Valve Vibrations in a Large Steam Turbine," K.E. Widell, Stal-Laval Turbin AB, Sweden

13. "Flow-Induced Vibrations of an Anchor Agitator," R. King, British Hydromechanics Research Association, UK and R. Jones, Imperial Chemical Industries, UK

14. "Vibrations of Pump Shafts," W.Y. Chow, A.B. Rudavsky, J.C. Wong, Hydro Research Science, USA

15. "Rock Drilling Tool with Pulsed Jets," D. Milan, G. Berthollon, R. Toueille, Bouchayer & Vialet, France

TECHNICAL SESSION D:
"Bridge Decks, Beams, and Cables"

General Lecture: "On the State of Stability Considerations for Suspended-Span Bridges Under Wind," R.H. Scanlan, Princeton University, USA

1. "Vortex Shedding Oscillations of Bridge Deck Sections," I. Konishi, Chubu Institute of Technology, Japan and N. Shiraishi, M. Matsumoto, Kyoto University, Japan

2. "Model and Full-Scale Response to Wind Action of the Cable Stayed Box Girder West Gate Bridge," W.H. Melbourne, Monash University, Australia

3. "On Subspan Oscillation of Two Coupled Conductors with One in the Wake of Another," Y.T. Tsui, Institut de Recherche de l'Hydro-Quebec, Canada

4. "Wind-Induced Oscillations of Some Steel Structures," (invited paper), H. Bardowicks, Techn. University Hannover, F.R. Germany

5. "Approaches to the Suppression of Wind-Induced Vibrations of Structures," (invited paper), R.L. Wardlaw, National Research Council of Canada

TECHNICAL SESSION E:
"High-Rise Buildings and Structures"

General Lecture: "The Response of Structures to Turbulent Wind," A.G. Davenport, The University of Western Ontario, Canada

1. "Assessment of Wind Loads for Glazing Design," (invited paper), W.A. Dalgliesh, National Research Council of Canada

2. "Wind-Induced Vibrations of Towers and Stacks," (invited paper), H. Ruscheweyh, Technical University Aachen, F.R. Germany

3. "Experiences with Cross-Wind Vibrations of Columns and Chimneys," H. van Kouten, Applied Scientific Research (TNO), Netherlands

4. "Oscillation Due to Vortex Shedding of Reinforced Concrete Chimneys of Rectangular Cross-Section," T.A. Wyatt, Imperial College London, UK

5. "Full-Scale Experiments on a Tall Steel Stack," H. Ishizaki, Kyoto University, Japan and T. Makihata, M. Araki, Hitachi Shipbuilding and Engineering Co., Japan

6. "The Use of Slats to Suppress Vortex-Induced Oscillations of Slender Structures," H.Y. Wong, R.N. Cox, University of Glasgow, UK

7. "Damping of Structures Containing Fluids and their Relevance to Wind-Induced Vibrations," D.J. Johns, University of Technology Loughborough, UK

8. "The Wind-Induced Vibration of a Tall Building," B.R. Ellis, R.A. Evans, A.P. Jeary, B.E. Lee, Building Research Establishment, UK, University of Sheffield, UK

TECHNICAL SESSION F:
"Hydraulic Structures"

General Lecture: "Development of Vibration-Free Gate Design: Learning from Experience and Theory," P.A. Kolkman, Delft Hydraulics Laboratory, Netherlands

1. "Bureau of Reclamation Experience with Flow-Induced Vibrations," (invited paper), H.T. Falvey, US Bureau of Reclamation, USA

2. "Stability of Vertically Movable Gates," A. Vrijer, Delft Hydraulics Laboratory, Netherlands

3. "Gate-Vibration at El Chocon Hydro-Power Scheme, Argentina," J.D. Hardwick, M.J. Kenn, Imperial College London, UK and W. Mee, Sir Alexander Gibb & Partners, UK

4. "Causes and Remedy of Vibrations of a High Head Gate," P.C. Saxena, C.P. Venkataraman, V. Ramanathan, R.M. Sinnarkar, Central Water and Power Research Station, India

5. "Flap Gate Oscillation," K. Ogihara, Tokyo University, Japan and S. Ueda, Ishikawajima-Harima Heavy Industries, Japan

6. "Hydraulically Induced Vibrations in a Bear-Trap Weir," F. Merkle, Voith GmbH, F.R. Germany

7. "Excitation and Vibration of a Grid Gate," R.J. de Jong, J.W.G. van Nunen, Delft Hydraulics Laboratory, Netherlands

8. "Vibrations Due to Air-Water Flow Below a Tainter Gate," G. Rouvé, F.J. Traut, Technical University Aachen, F.R. Germany

9. "Dynamic Instability of Tainter-Gates Caused by Surface Waves," N. Ishii, K. Imaichi, Osaka University, Japan and A. Hirose, Kobe Steel Industrial Company, Japan

10. "Seal Vibrations," (invited paper), K. Petrikat, University of Stuttgart, F.R. Germany

11. "Corps of Engineers Experience with Flow-Induced Vibrations," (invited paper), E.B. Pickett, U.S. Army Waterways Experiment Station, USA

12. "Eliminating Pressure Fluctuations at the Floating Bulkheads of the Guri Dam Project," K. Zagustin, P. Solana, Universidad Central de Venezuela, Venezuela

13. "Vibrations of the Bolarque Dam," M.J. Kenn, A.C. Cassell, P. Grootenhuis, Imperial College London, UK

14. "Self-Excited Oscillatory Surface Waves," F.G. Rohde, G. Rouvé, E. Pasche, Technical University Aachen, F.R. Germany

TECHNICAL SESSION G:
"Ship Structures"

General Lecture: "Review of Theoretical and Experimental Procedures for Prediction of Ship-Propeller Induced Excitations," J.P. Breslin, Stevens Institute of Technology, USA

1. "Calculations, Measurements and Resulting Remedies for Vibration Problems on Ro/Ro Ships," C. Nath, H.G. Payer, E. Pless, Germanischer Lloyd, F.R. Germany

2. "Propeller Singing," E. Reed, Littleton Research and Engineering Corp., USA

3. "Propeller Exciting Forces Estimated from Measured Acceleration of Vertical Hull Vibration of Ships," T. Kumai, Mitsui Shipbuilding Co. Ltd., Japan

4. "Effects of Propeller-Hull Configurations on Vibratory Excitation of Ships," J.P. Breslin, S. Tsakonas, D. Valentine, Stevens Institute of Technology, USA

50th SHOCK AND VIBRATION SYMPOSIUM
16-18 October 1979

Antlers Plaza Hotel
Colorado Springs, Colorado

The 50th Shock and Vibration Symposium, sponsored by the Shock and Vibration Information Center (SVIC), was held in Colorado Springs, Colorado in October. It was hosted by the United States Air Force. The formal technical program consisted of more than 65 papers (see Vol. 11, No. 9 of the **DIGEST** for the complete program; paper summaries are available from SVIC; papers will be published in the **SHOCK AND VIBRATION BULLETIN**). A series of technical plenary sessions was initiated at this symposium. In the first session, Dr. Robert M. Mains delivered the first Elias Klein Memorial Lecture - "Measurement in Perspective." Henry Pusey, Director of the SVIC, the members of the SVIC staff, and the Program Committee are to be congratulated for assembling an interesting program. Jerome Pearson of the Air Force Flight Dynamics Laboratory, Wright Patterson AFB was responsible for organizing the excellent opening session. Among the 350 participants were representatives of the federal government, industry, and academic institutions. The combination of formal and informal technical programs effected a meaningful transfer of shock and vibration technology.

The Opening Session

The opening session was chaired by Jerome Pearson. Symposium participants were welcomed on behalf of the United States Air Force Academy by General William A. Orth, Dean of the Faculty, who described the English and writing courses of the Academy. He offered flattering comments on the technical writing contained in the **DIGEST**. Col. Ralph Kuster welcomed the participants on behalf of the Air Force Flight Dynamics Laboratory. General Robert J. Baer, Deputy Commanding General for Material Development, U.S. Army Material Development and Readiness Command, was the first invited lecturer. He spoke on real world shock and vibration problems encountered in weapon systems: even though simplicity in design is the goal, weapon systems are becoming more complex and environments have become more severe than those encountered in the past. He noted that design of effective military hardware remains a challenge despite new technology and cited the XMI Tank as an example. He spoke about the weldment problems emerging from designs for high-energy attack and the suspension problems resulting from high surface speeds. He described the advanced materials (high fragmentation steels) now being used in designs capable of withstanding severe environments. He described transportation handling and packaging problems encountered with ammunition design. The stress levels on handling nuclear projectiles are the most sensitive. General Baer described some advanced materials, including organic composites, metal matrix components, and ceramics. He cited the use of these materials in helicopter gears, blading, and bearings. Helicopter vibration isolation equipment described included the Dynamic Antivibration Isolator. He reviewed problems and solutions to vibration problems -- including some combination shock and vibration problems -- encountered in the Remotely Piloted Vehicle program. General Baer noted that new weapons and weapon systems are so sensitive that they cannot withstand normal troop handling; thus, new means will have to be devised to protect equipment. General Baer's closing remarks had to do with the fact that defense systems are now very costly to produce and maintain in the field and that shock and vibration problems will have to be solved to maintain durability and reliability.

The second keynote speaker, Dr. T.G. Horwath, the Director of Navy Technology, painted a bleak future for technology and civilization unless some changes are made. Dr. Horwath began his address with a discussion of the early history of SVIC, its purpose and mission, and its accomplishments to date. He spoke of the golden age of technology after the Sputnik launching and the immense benefits obtained from coordinated research. As a result of Sputnik, spectacular achievements were made without controls. Among the achievements he cited were those of the Navy -- shock resistant ships and quiet submarines. Optimum tradeoffs between shock and vibration were obtained. He noted DDAM and finite element-oriented fluid-structure interaction codes. Dr. Horwath's projected future technological developments included computer simulation and analysis for expediting ship design; he mentioned advances in processing data, including computer graphics. Dr. Horwath noted, however, that the current atmosphere in which we work is not conducive to future advances -- we are too preoccupied with current problems: controls on fundamental research; general public disenchantment with technology voiced by environmental movements and counter culture groups; experts ready to testify on the evils of technology; and balance of payments problems. These factors have eroded the development of technology and will continue to do so in the future. Dr. Horwath feels that we will soon have to choose between present crises and the future because our adversaries are using U.S. technology to modernize their armed forces. He claims that an innovative technology will be the key to a nation's military and economic well being and that unless the U.S. recognizes that innovation pays off and shows an increased willingness to take risks, the standard of living in the U.S. will suffer along with military security. In closing Dr. Horwath noted that innovations attributable to 5% of the population are responsible for 95% of the progress.

General B.D. Ward, Director of Science and Technology, Air Force Systems Command, spoke on vibration testing of military hardware and new equipment. He cited equipment failures and loss of reliability due to excessive vibration. General Ward discussed the need for new supply aircraft and the type advanced materials to be used. He noted the sensitivity to vibration of new high-energy lasers and active control systems and mentioned the space shuttle, which would allow deployment of decoys. He reviewed the function of military satellites -- to control troop and weapon deployments and to locate enemy positions. He spoke of some future challenges -- energy-efficient vehicles, chronic inflation, and material shortages.

Wade Dorland, Manager of the Federal Railroad Administration Rail Dynamics Laboratory, was the final keynote speaker. His address was concerned with the testing of tomorrow's railroads today. Dorland showed slides of the facilities of rail test centers and discussed testing techniques. He showed movies of several rail car impact tests and described such new rail designs as flywheel energy storage systems, traction motors, and brake systems. He described the new facility for accelerated service testing and a vibration test unit that uses 16 independently actuated, programmed shakers.

The Technical Program

Prior to the first plenary session Dr. Charles Morrow was awarded the membership grade of Fellow in the Institute of Environmental Sciences by Robert Hancock, President of the IES.

The first plenary session featured the first Elias Klein Memorial lecture by Dr. Robert M. Mains; he spoke on "Measurement in Perspective." Dr. Mains was introduced by Dr. W.W. Mutch, former Director of SVIC. Dr. Mains reviewed the accomplishments of Dr. Klein, the founder of SVIC, and the early history of the Center. Dr. Mains discussed the state of measurement in 1940, with particular attention to dynamic measurement and historical background. He assessed the accelerated development of measurement applications during and following World War II to 1950, when synthetic materials, miniaturization, and analog computers began to affect capability and accuracy. During the 1950s, electrodynamic shakers, printed circuits, statistical techniques, and digital computers were integrated into measuring systems.

Equivalence in damage potential (or accumulation) for different testing techniques - steady sinusoidal, swept sinusoid, random, step programmed, shock, and others - were studied and researched intensively. By the early 1960s the shock spectral dip and other resonance-associated phenomena were understood well enough that designs for various environments were possible. Dr. Mains noted that ever faster and smaller computers, together with solid state electronics, have made possible integrated measuring systems that are compact and lightweight. In the area of sensors accelerometers weighing less than one gram are rugged and accurate. The Fast-Fourier-Transform is now small enough to be built into integrated systems, so that on-line results are available immediately.

He noted that the physical, electrical, and optical principles used in measurement are the same now as they were in 1940. The use of these principles in devising end instruments, intermediate signal conditioners and processors, and terminating devices has produced systems that measure, process, and record almost any phenomenon. As new phenomena are observed, new instruments will probably be devised to measure them. Meanwhile, work toward further miniaturization and system integration will continue.

The second plenary lecture, given by Mr. Robert W. Hager, was titled "Dynamic Analysis and Design Challenge for the Future." Mr. Hager, who was introduced by Dr. Eugene Sevin, expressed concern about the way dynamic analysis is conducted today. He feels that much improvement would result if available techniques were more widely used. Mr. Hager reviewed the state of dynamic analysis as it existed at the first, thirty third, and fiftieth symposia. At the first Symposium in 1947 the single-degree-of-freedom model was well known. At the thirty third Symposium in 1962 real time analog computers and some digital computers were being used for analysis. The physical size of problems was limited by computer capacity at that time. Today, however, the digital computer is used almost exclusively and can provide weight performance, and cost optimization for designs. He noted that the computer has been much more cost effective than development tests. Mr. Hager told of his concern with the use of mathematical analysis in engineering. Excessive time is used in the hardware design/development cycle due to the present iterative procedure required by system tests. He feels that the use of design optimization techniques would be more cost effective. Another concern was the fact that engineers are not using available analytical capability: some engineers are still using static load factors in dynamic analysis. A third concern was lack of confidence in analytic results; current attitudes of both managers and engineers must change. Mr. Hager assessed the future of dynamic analysis and design, including the challenge of large hardware for which environmental testing will not be possible; the use of microprocessors in design analysis; and automatic design through analysis. He summarized techniques and procedures for system design, noting that a change in attitude among experts and managers will be necessary if we are to progress in this area.

The third plenary lecture on materials in dynamics was given by Mr. Richard Shea and Mr. John Mescall. The speakers were introduced by Mr. Michael Condouris.

The plenary speakers discussed the Army Materials and Mechanics Research Center (AMMRC) and its assigned mission of managing and conducting the Army's technology base programs in structural materials and solid mechanics. The dynamic behavior of materials, especially to shock, forms an important part of these research efforts. AMMRC first became involved with shock wave research when they applied hydrodynamic computer codes to the penetrator-armor interaction problem; the Center now has considerable experience in applying this technology to various Army materials problems. The goals have been to provide guidelines for using existing materials and to develop new materials for armor, penetrators, and fragment devices. Dr. Mescall noted that existing codes do well in predicting the shock response of solids but only up to the point of failure. This is proof that failure mechanisms depend strongly on material properties; current research efforts, both experimental and numerical, thus aimed at examining failure mechanism phenomena.

The fourth plenary lecture, on dynamic testing, was given by Dr. Allen J. Curtis. Dr. Curtis was introduced by Mr. D.C. Kennard formerly of NASA Goddard Spaceflight Center. Dr. Curtis covered the evaluation of dynamic testing from the middle 1950s to the present. He discussed the new techniques of today, including spectrum analysis, coherence analysis, and other statistical techniques. He noted that the first purpose of tests is to provide information about structural characteristics; the second purpose is to test the system for function and fatigue resistance; and the third purpose relates to product assurance -- reliability and quality. Dr. Curtis identified the various types of tests – design/development, flight worthiness, design verification, design qualification, preproduction, production sampling, and production acceptance screening. His comments on screening production items for flaws by selective testing were interesting and informative. He reviewed the goals of a good screening test -- flaws precipitated rapidly, no inappropriate design failures, and no flaws induced. Dr. Curtis noted that we underuse control systems for testing and should spend more time understanding testing limitations.

Several speakers were invited to give special lectures during the Symposium. These lectures, many of which will be printed in the 50th **SHOCK AND VIBRATION BULLETIN**, include

- D.J. Ewins, Imperial College, London, England, "State of the Art of Mobility Measurement Techniques - Progress Review"
- F.E. Ostrem, GARD Inc./GATZ, Niles, IL, "Assessment of the Common Carrier Shipping Environment"
- A.W. Leissa, Ohio State University, Columbus, Ohio, "The Relative Complexities of Plate and Shell Vibrations"
- J.L. Goldberg, CSIRO National Measurement Laboratory, Lindfield, N.S.W., Australia, "Applications of Tuned Mass Dampers, Downunder"
- P.C. Jennings, California Institute of Technology, Pasadena, California, "Earthquake Engineering in the People's Republic of China"
- K.E. Meier-Dornberg, Technische Hochschule, Darmstadt, Federal Republic of Germany, "An Overview of Shock Analysis and Testing in the Federal Republic of Germany"

The technical sessions in the Symposium contained many interesting and informative papers. The sessions were on instrumentation, data analysis, dynamic analysis, design techniques, dynamic properties of materials, applications of materials, vibration and acoustics, shock testing, special topics in dynamics, and fragments. An interesting session on short discussion topics proved popular again.

The Fiftieth Shock and Vibration Symposium was both technically informative and interesting. The addition of the plenary sessions to the Symposium agenda was very successful. The plenary speakers provided a much needed overview of today's shock and vibration technology and some interesting philosophical insights. Papers presented at the Symposium will be reviewed for quality of technical content and published in the 50th **SHOCK AND VIBRATION BULLETIN** available from the SVIC.

R.L.E.

STANDARDS REVIEW

American National Standards Institute
Committee S2
Mechanical Vibration and Shock

The semiannual meeting of ANSI S2 was held at the 50th Shock and Vibration Symposium on October 18, 1979 in Colorado Springs, Colorado. A summary of significant S2 committee activities in given below. Emphasis is placed on letter ballots and future activities of existing committees:

S2-54
Atmospheric Blast Effects

Work on revision of the fourth draft of a document on source airblast description for single point explosions in air with a guide to evaluation of atmospheric propagation and effects is complete. The purpose of this manual is to provide a consensus of quantitative definitions of explosion characteristics, effects of atmospheric propagation, and typical responses to explosion waves. This document will be issued in 1980.

S2-63
Vibration and Shock Isolators

This committee is currently working on a revision of ANSI S2.8-1972 "Guide for Describing the Characteristics of Resilient Mountings." Interactions with SAE Committee G-5 continue.

S2-65
Balancing Technology

This committee has several documents in preparation for flexible rotor balancing. In addition, ANSI Standard S2.19 (1975) on rigid rotor balancing is under revision. The document ISO/DIS 5406, "The Mechanical Balancing of Flexible Rotors," was received for vote by the U.S. Comments are being coordinated by Nevile F. Rieger, Chairman of S2-65.

S2-66
Statistical Analysis of Vibration and Shock Data

Dr. Karl Hedrick, Chairman, has proposed that the scope of the working group include methods of analyzing and presenting shock and vibration data including digital and analog processing. S2-66 will begin updating ISO/TC108/DIS 4865, Methods for Analysis and Presentation of Data.

S2-67
Measurement and Evaluation of Vibration and Shock in Land Vehicles

The proposed scope of this work group includes measurement and evaluation methods for road surface inputs, rail inputs, and vibration environment of land vehicles.

S2-72
Vibration Testing

This working group is engaged in the activities of the ISO/TC108 counterpart WG5. ISO/DP 6070 - an international standard for auxiliary tables for vibration generators is at the first draft stage. ISO/DIS 5344, "Electrodynamic Test Equipment for Generating Vibration - Methods for Describing Equipment Characteristics" is in its final stages of development.

S2-73
Characterization of Damping Materials

Work is progressing on a new standard on the characterization of damping materials. This document is based on work performed at Wright-Patterson AFB on damping characterization techniques under the direction of John Henderson who also is chairman of this committee. This work is progressing in coordination with ASTM E33.

S2-74
Measurement of Mechanical Mobility

This active committee under the guidance of P.K. Baade is working on a set of five standards covering the various aspects of mobility. The first of the five documents - on terminology and transducers - has been completed and is available from the Acoustical Society of America, Standards Manager.

S2-76
Vibration Levels of Machines

Several machinery vibration standards are being developed in this working group under the direction of Paul Maedel. A draft standard on shaft vibration measurement is being revised for submission to the next ISO/TC108/SC2/WG1 working group meeting. Negative votes are being resolved on a proposed ANSI Standard for evaluation of mechanical vibration of machines with operating speeds from 600 - 12 000 rpm as measured on structural members. This group has classified machine systems according to vibrating characteristics in preparation for the development of a group of rotating machinery vibration standards.

S2-77
Vibration Levels of Ships

This group continues to be very active at the international level, developing standards for measurement and evaluation of shipboard vibration. Specific documents involve a code for the measurement and reporting of shipboard vibration data, code for the measurement and reporting of shipboard local vibration data, and the interim guidelines for the evaluation of vibration in merchant ships.

S2-78
Measurement and Evaluation of Structural Vibration

The working group intends to establish standards on the measurement and evaluation of mechanical shock and vibration of all stationary structures including buildings, bridges, and dams. The shock and vibration may be transmitted into the structure from the environment or generated within the structure itself.

S2-81
Calibration Methods for Shock and Vibration Pickups

A new working group, use and calibration of vibration and shock measuring instruments, was formed under the chairmanship of M.R. Serbyn of, the National Bureau of Standards. Mr. Serbyn is in the process of consolidation of tasks of S2-51/S2-68 and will be enlisting new members and developing a new scope of activities. S2-81 will be involved with SC3 of ISO/TC108 specifically on the revision of documents on the calibration and specifying of shock and vibration measurements.

S2-82
Elastomeric Couplings in a Shock and Vibration Environment

This new group is being formed by Dr. Eshleman of the Vibration Institute to standardize methods of obtaining shaft coupling vibration characteristics such as stiffness and damping. In addition a standard on coupling selection will be developed.

An S2 Steering Committee has been organized to deal with the following activities:

- Expediting production of needed standards
- Review of existing standards
- Review of procedures, technical and administrative
- Identification of areas of standardization
- Interface with international (IEC and ISO) and other national standards' activities
- Selection of experts in needed areas
- Guidance for participants in working groups
- Representation (on S2)
- Promotion and funding support, including communication with appropriate bodies

ABSTRACT CATEGORIES

MECHANICAL SYSTEMS

Rotating Machines
Reciprocating Machines
Power Transmission Systems
Metal Working and Forming
Isolation and Absorption
Electromechanical Systems
Optical Systems

STRUCTURAL SYSTEMS

Bridges
Buildings
Towers
Foundations
Underground Structures
Harbors and Dams
Roads and Tracks
Construction Equipment
Pressure Vessels
Power Plants

VEHICLE SYSTEMS

Ground Vehicles
Ships
Aircraft
Missiles and Spacecraft

BIOLOGICAL SYSTEMS

Human
Animal

MECHANICAL COMPONENTS

Absorbers and Isolators
Springs
Tires and Wheels
Blades
Bearings
Belts and Conveyors
Gears
Clutches
Couplings
Fasteners
Linkages
Valves
Seals

STRUCTURAL COMPONENTS

Strings and Ropes
Cables
Bars and Rods
Beams
Cylinders
Columns
Frames and Arches
Membranes, Films, and Webs
Panels
Plates
Shells
Rings
Pipes and Tubes
Ducts
Building Components

ELECTRIC COMPONENTS

Controls (Switches, Circuit Breakers)
Motors
Generators
Transformers
Relays
Electronic Components

DYNAMIC ENVIRONMENT

Acoustic Excitation
Shock Excitation
Vibration Excitation
Thermal Excitation

MECHANICAL PROPERTIES

Damping
Fatigue
Elasticity and Plasticity

EXPERIMENTATION

Measurement and Analysis
Dynamic Tests
Scaling and Modeling
Diagnostics
Balancing

ANALYSIS AND DESIGN

Analogs and Analog
Computation
Analytical Methods
Modeling Techniques
Nonlinear Analysis
Numerical Methods
Statistical Methods
Parameter Identification
Mobility/Impedance Methods
Optimization Techniques
Design Techniques
Computer Programs

CONFERENCE PROCEEDINGS AND GENERAL TOPICS

Conference Proceedings
Tutorials and Reviews
Criteria, Standards, and
Specifications
Bibliographies
Useful Applications

ABSTRACTS FROM THE CURRENT LITERATURE

Copies of articles abstracted in the DIGEST are not available from the SVIC or the Vibration Institute (except those generated by either organization). Inquiries should be directed to library resources. Government reports can be obtained from the National Technical Information Service, Springfield, VA 22151, by citing the AD-, PB-, or N- number. Doctoral dissertations are available from University Microfilms (UM), 313 N. Fir St., Ann Arbor, MI; U.S. Patents from the Commissioner of Patents, Washington, D.C. 20231. Addresses following the authors' names in the citation refer only to the first author. The list of periodicals scanned by this journal is printed in issues 1, 6, and 12.

ABSTRACT CONTENTS

MECHANICAL SYSTEMS

ROTATING MACHINES

(Also see Nos. 67, 123, 124, 125, 126, 183)

80-1

Nonsynchronous Vibrations Observed in a Supercritical Power Transmission Shaft

M.S. Darlow and E.S. Zorzi
Mechanical Technology, Inc., 968 Albany-Shaker Rd., Latham, NY, ASME Paper No. 79-GT-146

Key Words: Power transmission systems, Shafts, Flexible rotors, Whirling

Nonsynchronous vibrations from several sources are observed while running a test rig designed to simulate the operation of a supercritical power transmission shaft. The test rig is run first with very light external damping and then with a higher level of external damping, for comparison. This paper presents a review of the analysis performed and a comparison with experimental data. A thorough discussion of the observed nonsynchronous whirl is also provided.

80-2

Stability and Nonlinear Response of Rotor-Bearing Systems with Squeeze Film Bearings

L.E. Barrett
Ph.D. Thesis, The Univ. of Virginia, 331 pp (1978) UM 7916233

Key Words: Rotor-bearing systems, Squeeze-film bearings, Dynamic stability, Unbalanced mass response

A method of analyzing the first mode stability and unbalance response of multimass flexible rotors is presented whereby the multimass system is modeled as an equivalent single mass modal model including the effects of rotor flexibility, general linearized hydrodynamic journal bearings, squeeze film bearing supports and rotor aerodynamic cross coupling. Expressions for optimum bearing and support damping are presented for both stability and unbalance response. The method is intended to be used as a preliminary design tool to ascertain the effects of bearing and support changes on rotor-bearing system performance. Methods of calculating the nonlinear squeeze film bearing forces for finite length bearings are developed. Three industrial rotor systems are analyzed for stability and unbalance response. Linear and nonlinear analysis with squeeze film bearing supports are presented using nonlinear steady state and time transient techniques to verify the linear designs.

80-3

Problem of Rotor Passing Through Critical Speed with Gyroscopic Effect (2nd Report, Generating of Self-Excited Vibration Caused by Internal Damping)

K. Nonami and M. Miyashita
Faculty of Engrg., Tokyo Metropolitan Univ., Setagaya-ku, Tokyo, Japan, Bull. JSME, 22 (169), pp 911-918 (July 1979) 16 figs, 3 tables, 9 refs

Key Words: Rotors, Critical speed, Resonance pass through

The self-excited vibration of a rotor caused by the internal damping forces active in the nonstationary vibration as it passes through the critical speed is analyzed theoretically and experimentally under the assumption of the linear internal damping forces. The internal damping is quantitatively derived using the first approximated asymptotic equation and is verified experimentally for various external damping conditions.

80-4

The Natural Frequencies of a Thin Rotating Cantilever with Offset Root

C.H.J. Fox and J.S. Burdess
Dept. of Mech. Engrg., Univ. of Newcastle upon Tyne, Newcastle upon Tyne NE1 7RU, UK, J. Sound Vib., 65 (2), pp 151-158 (July 22, 1979) 7 figs, 5 refs

Key Words: Cantilever beams, Rotating structures, Natural frequencies

In this paper previous analyses of rotating cantilevers are extended to allow consideration of the case where the root offset from the spin axis is such that part of the beam is directed radially inwards towards the axis of rotation. In this situation the fundamental natural frequency is a function of the spin frequency. The behavior of higher modes of vibration is also discussed.

RECIPROCATING MACHINES

80-5

Aircraft Hydraulic Systems Dynamic Analysis

H. DeGarcia, J.B. Greene, R.J. Levek, and N.J. Pierce
McDonnell Aircraft Co., St. Louis, MO, Rept. No. AFAPL-TR-78-77, 357 pp (Oct 1978)
AD-A067 549/6GA

Key Words: Hydraulic equipment, Mathematical models, Digital simulation, Pumps

This report describes the continued development and test verification of digital computer models used to simulate hydraulic systems under dynamic conditions. Frequency and transient models of a variable delivery vane pump and a fixed displacement piston-type hydraulic motor are included. Additional verification and development of the transient model for the piston-type hydraulic pump was accomplished. Verification and development of a computer program to describe the mechanical response of a hydraulic line to internal excitations from a hydraulic pump was begun. This effort was a continuation of the basic contract wherein four computer programs for hydraulic system dynamic analysis were developed.

METAL WORKING AND FORMING

80-6

Non-Uniformly Variable Errors Inherent in the Turning Operation

A.F. Rashed, H.R. El-Sayed, and T. El-Wardany
Production Engrg. Dept., Faculty of Engrg., Alexandria Univ., Alexandria, Egypt, Wear, 55 (1), pp 59-70 (July 1979) 11 figs, 9 refs

Key Words: Metal working, Cutting, Dynamic excitation

Variations of the depth of cut during the turning operation result in the generation of dynamic cutting forces which act upon the processing system to introduce non-uniformly variable errors. These are in turn transferred to the turned workpiece. Equations were derived to describe the dynamic forces generated owing to initial errors in the blank. Evaluation of the dynamic forces generated and the corresponding transferred error is presented.

80-7

Static and Dynamic Analysis of Hydraulic Copying System Using Throttling Valve

S. Kato, K. Yamaguchi, and E. Marui
Dept. of Mech. Engrg., Faculty of Engrg., Nagoya Univ., Nagoya, Japan, J. Engr. Indus., Trans. ASME, 101 (3), pp 295-303 (Aug 1979) 20 figs, 2 tables, 2 refs

Key Words: Machine tools

The effect of dimension parameters of hydraulic copying control system using throttling valve on the copying accuracy is investigated from two points of view for good design of the system. One is the static characteristic in steady copying operation, and the other is the dynamic characteristics in machining a square shoulder and tapering. Some remarks which serve the design of the hydraulic copying system are clarified.

80-8

Development of a Hydraulic Chambered, Actively Controlled Boring Bar

D.J. Glaser and C.L. Nachtigal
Glendo Corp., Emporia, KS 66801, J. Engr. Indus., Trans. ASME, 101 (3), pp 362-368 (Aug 1979) 11 figs, 9 refs

Key Words: Cutting, Chatter, Active control, Machine tools

The main thrust of this research work is the design, development and evaluation of a new actuation concept for active control of the boring operation. The actuation concept was implemented using a special boring bar with two internal longitudinal hydraulic chambers. A pressure difference between these two chambers provides the driving force to create the desired tool-tip motion.

80-9

The Effect of Material Properties on the Radiation of Impact Sound from Cylinders

N.I. Dreiman, H.A. Evensen, and A.A. Hendrickson
Michigan Tech. Univ., Houghton, MI 49931, Exptl. Mech., 19 (9), pp 331-335 (Sept 1979) 7 figs, 11 refs

Key Words: Forging machinery, Noise reduction, Internal damping, Stiffness coefficients, Damping coefficients

A number of studies have investigated engineering methods of reducing forge-hammer noise by means of enclosure, blow reduction and external application of damping materials. In a theoretical and experimental study of sound radiation from cylindrical samples, candidate hammer materials are evaluated for potential reduction of radiated energy and energy spectrum.

ISOLATION AND ABSORPTION

(Also see No. 54)

80-10

The Effect of Wheel Suspension on Wheel Loads and Side Forces (Einfluss der Radaufhangung auf Radlasten und Seitenkrafte)

M. Mitschke

Institut f. Fahrzeugtechnik, Technische Universität Braunschweig, Hans-Sommer-Strasse 4, 3300 Braunschweig, Automobiltech. Z., 81 (7/8), pp 341-346 (July/Aug 1979) 10 figs, 3 tables, 9 refs

(In German)

Key Words: Ground vehicles, Suspension systems (vehicles)

Equations of motion of beam-axle and independent wheel suspension -- four different types of road-surface irregularity inputs -- measurement, hypothesis, auto- and cross spectral densities -- calculation of dynamic wheel load, rim side force and lateral adhesion efficiency during straight-line driving -- are discussed.

80-11

Automotive Suspension Control

H.K. Sachs

Dept. of Mech. Engrg. Sciences, Wayne State Univ., Detroit, MI, Rept. No. TARADCOM-TR-12377, 105 pp (Oct 1978)

AD-A068 405/0GA

Key Words: Suspension systems (vehicles), Active isolation

This report contains the software package for an adaptive optimal suspension control system relative to terrain random vibration disturbances. The proposed problem solution is shown to fall into two separate program categories: (a) recognition of the terrain and parameter selection, by means of an on-board minicomputer or microprocessor, (b) optimization of suspension parameters for arbitrary terrain configurations obtained from terrain statistics and executed on a centrally located stationary computer facility. The interface between the stationary computer facility and the on-board microprocessor is accomplished by means of a data bank prepared at the stationary facility and permanently stored in the memory of the on-board microprocessor.

80-12

Vibration Isolation Measurements on a Precision Machine Tool

R.L. Rhorer

Los Alamos Scientific Lab., NM, Rept. No. LA-UR-78-3252; Conf-7810128-2, 10 pp (1978)

N79-26404

Key Words: Isolators, Pneumatic isolators, Machine tools, Experimental data

Experiments performed to determine the effectiveness of an air isolation system for isolating a precision turning machine from floor vibrations are described. An accelerometer and spectrum analyzer were used for evaluating the performance of the machine and isolation system.

80-13

Vibration Isolation: Use and Characterization

J.C. Snowden

Applied Research Lab., Pennsylvania State Univ., University Park, PA, Rept. No. NBS/HB-128, 132 pp (May 1979)

PB-296 182/9GA

Key Words: Vibration isolators, Mounts, Noise control, Vibration reduction

The results of a search and critical evaluation of the literature pertinent to both the use and the characterization of the performance of antivibration mountings for the control of noise and vibration are described.

80-14

A Method for Modeling Perforated Tube Muffler Components. 1. Theory

J.W. Sullivan

Ray W. Herrick Laboratories, School of Mech. Engrg.,

Purdue Univ., West Lafayette, IN 47907, J. Acoust. Soc. Amer., 66 (3), pp 772-778 (Aug 1979) 4 figs, 2 tables, 12 refs

Key Words: Mufflers, Tubes, Perforated media, Mathematical models

A simple method is presented for modeling perforated muffler components such as concentric resonators with perforated flow tube, and expansion chambers and reverse flow chambers with perforated inlet and outlet tubes. The theory includes mean flow, but is confined to those configurations having one acoustically long dimension. It is based on a segmentation procedure in which each segment is described by a transmission matrix. The four-pole parameters of a component are then found from the product of the transmission matrices. The four-pole parameters for configurations having through flow, cross flow, and reverse flow are presented.

80-15

A Method for Modeling Perforated Tube Muffler Components. II. Applications

J.W. Sullivan

Ray W. Herrick Laboratories, School of Mech. Engrg., Purdue Univ., West Lafayette, IN 47907, J. Acoust. Soc. Amer., 66 (3), pp 779-788 (Aug 1979) 13 figs, 1 table, 14 refs

Key Words: Mufflers, Tubes, Perforated media

This paper is the second of two papers describing a method for modeling muffler components having perforated flow tubes, as for example those found frequently in automotive applications.

STRUCTURAL SYSTEMS

BRIDGES

80-16

Active Control and Stability of Cable-Stayed Bridge

J.N. Yang and F. Giannopolous

The George Washington Univ., Washington, D.C., ASCE J. Engr. Mech. Div., 105 (EM4), pp 677-694 (Aug 1979) 7 figs, 29 refs

Key Words: Bridges, Suspension bridges, Active control, Flutter

The dynamic stability analysis of a typical two cable-stayed bridge implemented by the active feedback control systems has been carried out. The control systems (hydraulic servomechanisms) are connected to the existing four suspension cables so that under severe wind storm these cables serve also as active tendons. The bridge is subjected to both the buffeting and the self-excited loads as well as the control forces form the tendons (cables). The analysis has been applied to the Sitka Harbor Bridge in Alaska, as well as a hypothetical bridge with a much smaller stiffness.

BUILDINGS

(Also see No. 121)

80-17

Energy Conservation and Noise Control in Residences

D.N. Keast

Bolt Beranek and Newman, Inc., Cambridge, MA, S/V, Sound Vib., 13 (7), pp 18-22 (July 1979) 5 figs, 2 tables, 12 refs

Key Words: Buildings, Noise reduction

Based upon a study of the literature on the two techniques – building noise control and building energy conservation – quantitative estimates have been developed for the average noise-control benefits to be obtained from selected energy-conservation modifications and vice-versa. Some conflicts between the objectives of building noise control and building energy conservation are pointed out.

80-18

The Acoustical Performance of Self-Protecting Buildings

D.J. Oldham and E.A. Mohsen

Dept. of Bldg. Science, Univ. of Sheffield, Sheffield S10 2TN, UK, J. Sound Vib., 65 (4), pp 557-581 (Aug 22, 1979) 19 figs, 1 table, 19 refs

Key Words: Buildings, Noise reduction

This paper describes the results of an investigation into the performance of self-protecting building configurations (buildings in which part of the structure acts to screen acoustic weak points such as windows). The techniques employed for this study are a combination of computer simulation and measurements on scale models. A method is presented of predicting the performance of self-protecting buildings, in terms of commonly used noise units, from knowledge of their geometry.

80-19

On the Coupled Torsional and Sway Vibrations of a Class of Shear Buildings

W.H. Wittrick and R.W. Horsington

Dept. of Civil Engrg., Univ. of Birmingham, Birmingham, UK, Intl. J. Earthquake Engr. Struc. Dynam., 7 (5), pp 477-490 (Sept/Oct 1979) 6 figs, 1 ref

Key Words: Buildings, Multi-story buildings, Torsional vibration, Flexural vibration

This paper is concerned with the free vibrations of a restricted class of multi-story shear buildings in which inertial coupling exists between the torsional and the two sway vibrations. The restrictions imposed are: that the shear centers of all stories lie on a vertical straight line; the principal axes of shear are in the same directions in all stories; the centers of mass of all floors lie on another vertical straight line; the radius of gyration about the shear center of every floor mass is the same; and the ratios of the two shear stiffnesses to the torsional stiffness do not vary from story to story.

80-20

Estimation of Structural System Parameters from Stationary and Non-Stationary Ambient Vibrations: An Exploratory-Confirmatory Analysis

W. Gersch and F. Martinelli

Dept. of Information and Computer Sciences, Univ. of Hawaii, Honolulu, Hawaii 96822, J. Sound Vib., 65 (3), pp 303-318 (Aug 8, 1979) 5 figs, 1 table, 18 refs

Key Words: Buildings, Wind-induced excitation, Parameter identification, Natural frequencies, Damping coefficients

The natural frequency and damping parameters of a building structure are estimated from a long ambient vibration record that shows considerable non-stationarity. The long record is segmented into 57 approximately independent one minute duration stationary time series segments. Each segment is low pass filtered to reject unwanted higher frequency modes and is analyzed by a 2SLS (two stage least squares) time domain parametric model procedure.

80-21

Blast Capacity Evaluation of Pre-Engineered Building

W. Stea, N. Dobbs, S. Weissman, P. Price, and J. Caltagirone

Ammann and Whitney, NY, Rept. No. ARLCD-CR-79004, AD-E400 301, 141 pp (Mar 1979)
AD-A068 504/0GA

Key Words: Buildings, Blast resistant structures, Dynamic tests

A series of dynamic tests was performed to evaluate the blast resistant capacity of pre-engineered buildings for use in Army Ammunition Plants.

80-22

Blast Upgrading of Existing Structures

B.L. Gabrielsen, G. Cuzner, and R. Lindskog

Scientific Service, Inc., Redwood City, CA, Rept. No. SSI-7719-4, 279 pp (Jan 1979)
AD-A066 998/6GA

Key Words: Buildings, Protective shelters, Nuclear explosion damage, Damage prediction

This report describes some upgrading concepts, develops practical techniques for predicting structural failure, and verifies the failure prediction methodology by comparing the analysis with structural failure test data developed under this program and available in the literature. The analyses and prediction techniques were applied to wood, steel, and concrete roof and floor specimens; and to static, dynamic, and combined loadings. The prediction methodology is founded on engineering mechanics, limit theory, and a statistical approach to failure analysis that enables realistic assessment to be made of failure probabilities based on the combined effects of statistical variation in materials, structural elements, and construction processes.

80-23

Cyclic Loading Tests of Masonry Single Piers. Volume 1: Height to Width Ratio of 2

P.A. Hidalgo, R.L. Mayes, H.D. McNiven, and R.W. Clough

Earthquake Engrg. Research Ctr., California Univ., Berkeley, CA, Rept. No. UCB/EERC-78/27, 142 pp (Nov 1978)
PB-296 211/6GA

Key Words: Buildings, Multistory buildings, Seismic response, Experimental data

A multistory masonry building research program was initiated in September 1972, and has continued for the past six years. This report presents the results of fourteen cyclic, in-plane shear tests on fixed ended masonry piers having a height to width ratio of 2. These fourteen tests form part of a test program consisting of eighty single pier tests. The test setup was designed to simulate insofar as possible the boundary conditions the piers would experience in a perforated shear wall of a complete building.

80-24
Investigation of the Elastic Characteristics of a Three Story Steel Frame Using System Identification
I. Kaya and H.D. McNiven
Earthquake Engrg. Research Ctr., California Univ., Richmond, CA, Rept. No. UCB/EERC-78/24, NSF/RA-780577, 117 pp (Nov 1978)
PB-296 225/6GA

Key Words: Buildings, Framed structures, Seismic response, System identification technique

In this report, three different models in increasing order of complexity have been used to identify the seismic behavior of a three story steel frame subjected to arbitrary forcing functions all of which excite responses within the elastic range. In the first model, five parameters have been used to identify the frame. Treating the system as a shear building, one stiffness coefficient is assigned to each floor and Rayleigh type damping is introduced with two additional parameters. The mass, assumed to be concentrated at a floor level, is kept constant throughout the study. The parameters are established using a modified Gauss-Newton algorithm.

80-25
Gravity Load and Vertical Ground Motion Effects on Earthquake Response of Simple Yielding Systems
O.A. Lopez and A.K. Chopra
Dept. of Civil Engrg., Univ. of California, Berkeley, CA, ASCE J. Engr. Mech. Div., 105 (EM4), pp 525-538 (Aug 1979) 9 figs, 8 refs

Key Words: Buildings, Earthquake resistant structures

Computed responses of idealized one-story yielding systems to earthquake ground motion are presented with the objective of evaluating the effects of gravity loads and vertical ground motions. These results demonstrate that the coupling between lateral and vertical deformations created by yielding in the system must be considered in order to predict the plastic part of vertical deformations due to horizontal ground motion.

FOUNDATIONS

80-26
Dynamic Response of Three-Dimensional Rigid Embedded Foundations
J.E. Luco, G.A. Frazier, S.M. Day, and R.J. Apsel
Dept. of Appl. Mechanics and Engrg. Sciences, California Univ., San Diego, La Jolla, CA, Rept. No. NSF/RA-780499, 108 pp (1978)
PB-296 617/4GA

Key Words: Foundations, Earthquake resistant structures

The dynamic response of rigid three-dimensional foundations embedded in the soil and excited by external forces as well as by different types of seismic waves is studied. The response of foundations to these types of excitations plays a key role in the evaluation of the response of structures to wind and earthquake loads. Two methods to obtain the dynamic response of foundations were developed and tested. The first method is based on performing a transient finite element analysis for a set of impulsive motions of the foundation. The second method is based on an integral equation formulation of the boundary-value problem which employs the Green's functions for layered viscoelastic media.

80-27
Energy Dynamics of SPT
J.H. Schmertmann and A. Palacios
Univ. of Florida, Gainesville, FL, ASCE J. Geotech. Engr. Div., 105 (GT8), pp 909-926 (Aug 1979) 10 figs, 1 table, 16 refs

Key Words: Soils, Dynamic tests

The dynamics of the standard penetration test (SPT) as determined from a study involving hammer impact and wave mechanics theory, field measurements of dynamic behavior during SPT, and computer simulations using the wave equation as developed for computer studies of pile driving are reported. The work includes methods for determining the amount of hammer energy reaching the sampler, and for determining the energy lost to the sampler.

79-28

Ballistic Pendulums and Dynamic Testing of Clays

F.N. Screwvala and R.P. Khera

Farrokh N. Screwvala, Inc., Cleveland, OH, ASCE J. Geotech. Engr. Div., 105 (GT8), pp 927-938 (Aug 1979) 8 figs, 1 table, 13 refs

Key Words: Clays, Dynamic tests, Testing techniques

Ballistic pendulums provide simple and effective means of testing clays at constant rate of strain. Tests were performed at strain rates of 1,400%/sec and 2,300%/sec.

UNDERGROUND STRUCTURES

80-29

Earthquake Response of Underground Pipelines

A. Hindy and M. Novak

Faculty of Engrg. Science, The Univ. of Western Ontario, London, Ontario, Canada, Intl. J. Earthquake Engr. Struc. Dynam., 7 (5), pp 451-476 (Sept/Oct 1979) 25 figs, 22 refs

Key Words: Pipelines, Underground structures, Interaction: soil-structure, Earthquake response

Seismic response of underground pipelines is investigated theoretically considering dynamic soil-pipe interaction. A lumped mass model of the pipe is employed with the soil reactions derived from static and dynamic continuum theories. The soil is supposed to be homogeneous or composed of two different media separated by a vertical boundary. Axial and bending stresses in the pipe due to travelling waves are examined.

80-30

Response of Tunnels to Incident SH-Waves

V.W. Lee and M.D. Trifunac

Dept. of Civil Engrg., Univ. of Southern California, Los Angeles, CA, ASCE J. Engr. Mech. Div., 105 (EM4), pp 643-659 (Aug 1979) 12 figs, 4 refs

Key Words: Tunnels, Vibration response, Interaction: structure-medium

The two-dimensional scattering and diffraction of plane-state SH-waves by a circular tunnel in a homogeneous elastic half space has been analyzed. Using the series solution of the problem for a general angle of wave incidence, stresses and deformations near the tunnel have been studied.

HARBORS AND DAMS

80-31

Considerations Concerning Earthquake Response Analysis of Rockfill Dams

R. Priscu, D. Stematiu, and L. Ilie

Civil Engineering Institute of Bucharest, Rev. Roumaine Sci. Tech., Mecanique, 24 (1), pp 3-12 (1979) 7 figs, 8 refs

Key Words: Dams, Earthquake response

The earthquake response of rockfill dams is strongly influenced by different assumptions concerning the fill behavior and excitation mechanism. Starting from the results obtained for some Romanian dams, the paper emphasizes the influence of material dynamic properties and nonsynchronous excitation along the dam foundation. Also, the earthquake behavior of a large rockfill dam during the Vrancea earthquake, on March 4, 1977, is shown.

80-32

Motion Analysis of Articulated Tower

S.K. Chakrabarti and D.C. Cotter

Marine Res. and Dev., Chicago Bridge & Iron Co., Plainfield, IL, ASCE J. Waterway Port Coastal & Ocean Div., 105 (WW3), pp 281-292 (Aug 1979) 7 figs, 2 refs

Key Words: Off-shore structures, Towers, Water waves, Fluid-induced excitation

An analytical method is developed to study the motions of a rigid articulated tower in waves. The wind, current and waves are assumed colinear. The solution is obtained in a closed form upon linearization of the nonlinear drag term. The analytical results are compared with the tests performed with a tower model in a wave tank. The tower was pivoted with a universal joint near the floor of the tank. The oscillation of the tower in the plane of the waves and the loads at the pin of the universal joint were measured during the test. In all cases the correlations between the theory and experiment are found to be satisfactory.

CONSTRUCTION EQUIPMENT

80-33

Assessment of Noise from "Quiet" Pile Drivers

H.S. Gill

Inst. of Sound and Vibration Research, Univ. of Southampton, Southampton S09 5NH, UK, J. Sound Vib., 65 (2), pp 193-202 (July 22, 1979) 5 figs, 2 tables, 5 refs

Key Words: Pile driving, Noise generation

This paper summarizes the results of a study aimed at defining the basic characteristics of noise from a range of pile driving devices which were either adapted or designed specifically to generate noise levels below those normally expected. The parameters studied were noise levels, spectra and waveform shapes. In addition, the noise reduction techniques employed by each manufacturer are described in detail.

PRESSURE VESSELS

80-34

Risk-Sensitive Markovian Policies for Detection and Maintenance of Fatigue Cracks in Pressure Vessels

A.V. Gheorghe

Dept. of Management Science, Bucharest Polytechnic, Rev. Roumaine Sci. Tech., Mecanique, 24 (1), pp 69-75 (1979) 3 figs, 6 refs

Key Words: Pressure vessels, Nuclear reactors, Fatigue (materials)

In the present paper a Markovian decision model for detection and optimal maintenance of fatigue cracks in pressure vessels, as applied to nuclear reactors, is presented. The study takes into consideration the special case when the decision-maker (the maintenance engineer) is a risk-sensitive person. Computational results are given following an investigation on a Light Water Reactor (LWR) pressure vessel.

80-35

Noise Level Considerations Associated with Power Plant Condenser Steam Dump

D.A. Fender

Ecolaire Condenser, Inc., Bethlehem, PA, ASME Paper No. 79-PVP-9

Key Words: Boilers, Sound pressure levels, Noise reduction

The sources of sound and approximate sound levels during steam dump are studied in relation to proper procedures for reducing these levels to that of normal plant operation. Acoustical measurements were taken at three typical U.S. electrical utility plants during routine startups.

80-36

Lateral Loads on Power Boilers

H.W. Hempel

Stearns-Roger, Inc., Denver, CO, ASCE J. Energy Div., 105 (EY2), pp 241-250 (Aug 1979) 4 figs, 9 refs

Key Words: Boilers, Seismic design, Design techniques, Standards and codes, Specifications

The structural section of power-boiler specifications should include lateral-force design criteria to minimize the possibility for critical damage and resulting financial loss during a furnace explosion.

80-37

Evaluation of the SRSS Combination of Primary Plus Secondary Dynamic Peak Responses

Z.N. Ibrahim

Sargent & Lundy Engineers, Chicago, IL, ASME Paper No. 79-PVP-40

Key Words: Nuclear power plants, Nuclear reactor components, Modal analysis

The dynamic loadings imposed on the nuclear power plant structures generate primary (inertial) and secondary (relative displacement) responses within the piping and/or equipment subcomponents to which they were constrained. The primary response is determined by the superposition of the dynamically amplified modal responses of each significant mode characterizing the subcomponent under consideration. However, the secondary response of this same subcomponent is determined by the superposition of the static influences of the supporting structure displacements. The engineering practice of combining these uncorrelated responses by SRSS (square root sum of squares) is examined.

VEHICLE SYSTEMS

GROUND VEHICLES

(Also see Nos. 10, 62, 66, 68, 69, 70, 87)

80-38

Comparison of Slip Angle and Non-Holonomic Constraint Vehicle Models

B.W. Mooring and J. Genin
School of Mech. Engrg., Purdue Univ., West Lafayette, IN 47907, J. Sound Vib., 65 (1), pp 85-95 (July 8, 1979) 10 figs, 6 refs

Key Words: Ground vehicles, Mathematical models, Interaction: tire-pavement, Slip amplitude

The motion of a simple, two degree of freedom vehicle is analyzed by using both a standard slip angle formulation and a non-holonomic constraint formulation. The two models are compared.

80-39

Noise Reduction on a Test Bus AS 3500 E (Lärmminderung am Versuchs-Reisebus AS 3500 E)

V. Tandara
Ulica Vita Kraigherja 12, YU-62000 Maribor, Automobiltech. Z., 81 (7/8), pp 333-338 (July/Aug 1979) 11 figs, 4 refs
(In German)

Key Words: Motor vehicles, Noise reduction

The paper deals with the sources of noise in buses as well as with the latest results of noise reduction in the interurban test bus AS 3500 E giving a description of the alterations carried out.

80-40

Optimization Criteria for Vehicles Travelling on a Randomly Profiled Road -- A Survey

T. Dahlberg
Div. of Solid Mechanics, Chalmers Univ. of Tech., S-421 96, Gothenburg, Sweden, Vehicle Syst. Dyn., 8 (4), pp 239-252 (Sept 1979) 1 fig, 11 refs

Key Words: Automobiles, Ground vehicles, Road roughness, Random excitation, Mathematical models, Computer programs, Optimization

A 5-DOF plane vehicle model is studied. A randomly profiled road is assumed to impart normally distributed stationary vertical random displacements to the front and rear wheels. Several vehicle performance criteria based on response mean square spectral densities are discussed. A computer program has been developed for optimization of two or more of the system parameters to make a vehicle response (or a weighted sum of responses) a minimum. Constraints on parameters and responses can be introduced. Ride comfort, road holding, energy absorption, fatigue failure and first-passage failure are studied. Numerical examples are given.

80-41

Vehicle Handling: Steady-State Theory and Practice

D.N. Bulman and N.A. Leadbetter
The Royal Military College of Science, Shrivenham, Auto. Engr. (UK), 4 (3), pp 29-32 (June/July 1979) 7 figs, 2 tables, 3 refs

Key Words: Automobiles, Transient response, Periodic excitation, Cornering effects

The work described in this article shows that simple two-dimensional steady-state handling theory will predict a vehicle's oversteering or understeering characteristics. Cornering stiffness values for different tire sizes are compared.

80-42

Ride Dynamics of Articulated Vehicles -- A Literature Survey

M.M. Elmadany, M.A. Dokainish, and A.B. Allan
Dept. of Mech. Engrg., McMaster Univ., Hamilton, Ontario, Canada L8S 4L7, Vehicle Syst. Dyn., 8 (4), pp 287-316 (Sept 1979) 1 table, 117 refs

Key Words: Articulated vehicles, Ride dynamics, Mathematical models, Reviews

This paper presents a review of the available literature describing the methods of modeling the vibrational response of articulated vehicles to the road inputs at the tire contact points. It states and discusses the mathematical techniques for obtaining road input characteristics, for modeling the vehicles in a range of degrees of freedom, and for performing the analysis necessary to obtain the vibrational repsonse. Finally, the indices that have been proposed for ride comfort and ride safety are given and the manner in which various researchers relate these to the vibrational characteristics of the vehicles is described.

80-43

SDP-40F/E-8 Locomotives. Test Results Report. Dynamic Performance Testing. Volume I

K. Kesler and T. Yang
Engineering Test and Analysis Div., ENSCO, Inc., Alexandria, VA, Rept. No. ENSCO/DOT-78/10/1, FRA/ORD-79/11-1, 44 pp (Sept 1977)
PB-296 294/2GA

Key Words: Locomotives, Dynamic tests

This volume covers a test on the Chessie System to collect as much data as possible on parameters suspected of causing SDP-40F derailments. A baseline locomotive, the E-8, considered a stable performer by professional railroad personnel was introduced into the tests for comparison purposes. Also, the SDP-40F was modified to simulate various stages of wear and states of maintenance, and tested after these modifications for comparison with tests run on a locomotive in 'like-new' condition.

80-44

SDP-40F/E-8 Locomotives. Test Results Report. Dynamic Performance Testing. Volume II

K. Kesler and T. Yang
Engineering Test and Analysis Div., ENSCO, Inc., Alexandria, VA, Rept. No. ENSCO/DOT-78/10/2, FRA/ORD-79/11-2, 173 pp (Sept 1977)
PB-296 295/9GA

Key Words: Locomotives, Dynamic tests, Testing instrumentation, Interaction: rail-wheel

This volume is a series of five appendices covering details of the Chessie System Test. These are: Appendix A - SDP-40F Consist Instrumentation (AAR); Appendix B - E-8 Consist Instrumentation (ENSCO, Inc.); Appendix C - Trackside Measurements of Wheel/Rail Forces (Battelle Columbus Laboratories); Appendix D - Locomotive Wheelset Instrumentation and Calibration (HITEC Corporation); and, Appendix E - Probabilistic Analysis for Locomotive Derailment (J H Wiggins Company).

80-45

Survey of Wheel -- Rail Rolling Contact Theory

J.J. Kalker
Dept. of Mathematics, Delft Univ. of Tech., The Netherlands, Vehicle Syst. Dyn., 8 (4), pp 317-358 (Sept 1979) 14 figs, 2 tables, 35 refs

Key Words: Interaction: rail-wheel, Rolling friction

This paper describes the theory of frictional rolling contact as far as it is significant for the wheel-rail system. The first part, mostly non-mathematical, contains a historical survey from the times of Carter and Fromm (1926) to the present day, in which all aspects of rolling contact theory are discussed. Included are a quantitative account of the results of Hertz theory and a table of the creepage and spin coefficients. The second part gives a present day account of the simplified theory and of the exact linear and non-linear theory. The paper closes with some recommendations for future research, of which the most pressing is a thorough investigation of the accuracy of simplified theory.

80-46

Some Basic Properties of Bogies, an Analytical Approach

C.P. Keizer
Vehicle Res. Lab., Delft Univ. of Tech., Delft, The Netherlands, Vehicle Syst. Dyn., 8 (4), pp 359-406 (Sept 1979) 11 figs, 11 refs

Key Words: Railroad cars, Dynamic stability

An analytical expression is derived for the low speed transfer function of a bogie, from which conclusions can be drawn regarding the effect of the elastic connections between wheelsets on dynamic behavior.

SHIPS

(Also see No. 207)

80-47

Ship Design and Noise Levels

G. Ward and A. Hoyland
NE Coast Instn. Engrs. Shipbldrs., Trans., 95 (4), pp 177-193 (July 1979) 8 figs, 6 tables, 10 refs

Key Words: Ships, Noise reduction

This paper is a review of the subject of noise in ships and a description of procedures to be undertaken to control noise levels. A description of sound transmission in structures is presented in the paper. Two estimating procedures are described for the calculation of sound levels.

80-48

An Analysis of the Quadratic Frequency Response for Added Resistance

J.F. Dalzell and C.H. Kim

Davidson Lab., Stevens Inst. of Tech., Hoboken, NJ, J. Ship Res., 23 (3), pp 198-208 (Sept 1979) 10 figs, 7 refs

Key Words: Ships, Frequency response method

The objective of the present work is to extend existing hydrodynamic theory for ship resistance added by waves to include time-dependent fluctuations, so that the so-called "quadratic frequency response function" for added resistance could be computed and compared with previously obtained experimental estimates. The concept of a quadratic frequency response function follows from the (nonphysical) theory for the general functional polynomial input-output model which was utilized in the previous experimental work. It was hoped that the present work, by providing a physical model, would either lend credibility to the previous work of expose its shortcomings.

80-49

Aft End Shaping to Limit Vibration

R. Rutherford

NE Coast Instn. Engrs. Shipbldrs., Trans., 95 (4), pp 197-214 (July 1979) 18 figs, 3 tables, 7 refs

Key Words: Ship hulls, Marine propellers, Propeller induced excitation

The empirical method presented in this paper is the result of the author's experience with shaping aft ends and with ships of high and low levels of propeller excited vibration, augmented by information from other sources.

AIRCRAFT

(Also see No. 192)

80-50

Demonstration of Aircraft Wing/Store Flutter Suppression Systems

C. Hwang, B.A. Winther, G.R. Mills, T.E. Noll, and M.G. Farmer

Northrop Corp., Hawthorne, CA, J. Aircraft, 16 (8), pp 557-563 (Aug 1979) 15 figs, 13 refs

Key Words: Aircraft wings, Wing stores, Active control, Vibration control, Wind tunnel tests

A wind tunnel test program was conducted to demonstrate the active wing/store flutter suppression systems on a lightweight fighter aircraft. The program, completed in mid-1978 included the design, analysis, fabrication, and testing of a scale model. The tests were conducted at the NASA Langley 16-ft Transonic Dynamics Tunnel. Three store configurations were selected for testing. Two of these configurations were deliberately designed to exhibit low flutter speeds with rapid reductions in damping at the incipient flutter condition.

80-51

Drones for Aerodynamic and Structural Testing (DAST) -- A Status Report

H.N. Murrow and C.V. Eckstrom

NASA Langley Research Ctr., Hampton, VA, J. Aircraft, 16 (8), pp 521-526 (Aug 1979) 3 figs, 13 refs

Key Words: Aircraft wings, Active control, Wind tunnel tests, Flight tests

A program for providing research data on aerodynamic loads and active control systems on wings with supercritical airfoils in the transonic speed range is described. Analytical development, wind-tunnel tests, and flight tests are included. A Firebee II target drone vehicle has been modified for use as a flight test facility. The program currently includes flight experiments on two aeroelastic research wings. The primary purpose of the first flight experiment is to demonstrate an active control system for flutter suppression on a transport-type wing. The experiment on the second research wing -- a fuel-conservative transport-type -- is to demonstrate multiple active control systems, including flutter suppression, maneuver load alleviation, gust load alleviation, and reduced static stability. Of special importance for this second experiment is the development and validation of integrated design methods which include the benefits of active controls in the structural design.

80-52

Aerodynamic Effects Induced by a Vectored High Aspect Ratio Nonaxisymmetric Exhaust Nozzle

D.L. Bowers

Air Force Flight Dynamics Lab., Wright-Patterson AFB, OH, J. Aircraft, 16 (8), pp 515-520 (Aug 1979) 16 figs, 7 refs

Key Words: Aircraft wings, Aerodynamic loads, Exhaust systems

Nonaxisymmetric exhaust nozzles exiting at or near the trailing edge of a lifting surface offer advanced aircraft configurations improved performance because of induced aerodynamic effects. An experimental investigation of these induced effects was conducted at Mach numbers from 0.3 to 0.9 on a half-span wing body configuration with a high aspect ratio vectoring (0, 15, 30 deg) nonaxisymmetric, exhaust nozzle incorporated into the wing trailing edge. Using the trimmed data, an optimum drag polar can be formed which uses all three vector angles.

80-53

Statistical Comparisons of Aircraft Flyover Noise Adjustment Procedures for Different Weather Conditions

A.W. Mueller and D.A. Hilton

NASA Langley Research Ctr., Hampton, VA, Rept. No. NASA-TP-1430; L-12626, 35 pp (May 1979) N79-24773

Key Words: Aircraft noise, Statistical analysis

Aircraft flyover noise spectra and effective perceived noise level (EPNL) values obtained under widely different weather conditions were adjusted according to a proposed national standard. The results were statistically compared with the same measured spectra adjusted according to an alternate procedure and with reference spectra and EPNL values obtained under almost ideal weather conditions. Three different ways to represent the weather condition through which the sound propagated were also evaluated.

80-54

Recent Developments in Helicopter Noise Reduction

H. Sternfeld, Jr.

The Boeing Vertol Co., Philadelphia, PA, Aeronaut. J., 83 (824), pp 306-313 (Aug 1979) 22 figs, 11 refs

Key Words: Helicopter noise, Noise reduction

The noise measurement unit which has been proposed, Effective Perceived Noise Level (EPNL), is the measure used for regulating jet aeroplanes. Because of the particularly unique characteristic of rotor noise, which under some conditions may become highly impulsive, there is consideration being given to developing an extra penalty based on some measure of impulsiveness such as crest factor.

80-55

An Experimental Investigation of the Effect of Rotor Tip Shape on Helicopter Blade-Slap Noise

D.R. Hoad

NASA Langley Research Ctr., Hampton, VA, Rept. No. NASA-TM-80066, 464 pp (May 1979) N79-25844

Key Words: Helicopter rotors, Helicopter noise

The effect of tip-shape modification on blade-vortex interaction-induced helicopter blade-slap noise is investigated. The general rotor model system (GRMS) with a 3.148 m (10.33 ft) diameter, four-bladed fully articulated rotor was installed in the Langley V/STOL wind tunnel. The tunnel was operated in the open-throat configuration with treatment to improve the semi-anechoic characteristics of the test chamber. Aerodynamic and acoustical data concerning the relative applicability of the various tip configurations for blade-slap noise reduction are presented without analysis or discussion.

80-56

Effect of Helicopter Noise on Passenger Annoyance

S.A. Clevenson and J.D. Leatherwood

NASA Langley Research Ctr., Hampton, VA, Rept. No. NASA-TM-80106, 18 pp (June 1979) N79-26782

Key Words: Helicopter noise, Human response

The effects of helicopter interior noise on passenger annoyance for both reverie and listening situations are investigated. The relative effectiveness of several metrics for quantifying annoyance response for these situations is also studied. The noise stimuli are based upon recordings of the interior noise of civil helicopter research aircraft. These noises are presented at levels ranging from approximately 70 to 86 d with various tonal components selectively attenuated to give a range of spectra.

80-57

A Simplified Rotor System Mathematical Model for Piloted Flight Dynamics Simulation

R.T.N. Chen

NASA Ames Research Ctr., Moffett Field, CA, Rept. No. NASA-TM-78575; A-7538, 28 pp (May 1979) N79-23977

Key Words: Helicopters, Mathematical models

The model was developed for real-time pilot-in-the-loop investigation of helicopter flying qualities. The mathematical model included the tip-path plane dynamics and several primary rotor design parameters, such as flapping hinge restraint, flapping hinge offset, blade Lock number, and pitch-flap coupling. The model was used in several exploratory studies of the flying qualities of helicopters with a variety of rotor systems. The basic assumptions used and the major steps involved in the development of the set of equations listed are described. The equations consisted of the tip-path plane dynamic equation, the equations for the main rotor forces and moments, and the equation for control phasing required to achieve decoupling in pitch and roll due to cyclic inputs.

80-58

Developments in Gear Analysis and Test Techniques for Helicopter Drive Systems

C. Albrecht

Boeing Vertol Co., Philadelphia, PA, ASME Paper No. 79-DE-15

Key Words: Helicopters, Transmission gears, Finite element technique, Testing techniques, Diagnostic techniques

Improvements in helicopter transmission gearing analysis and test techniques have been developed for the high-precision, lightweight gears used on the Heavy Lift, UTTAS and CH-47C and D helicopter drive systems. The use of finite element analyses for performing gear stress and natural frequency calculations -- transmission vibration/noise methodology, damage tolerance concepts, and failure detection methods -- is discussed.

MISSILES AND SPACECRAFT

(Also see No. 92)

80-59

An Impedance Technique for Determining Low-Frequency Payload Environments

K.R. Payne

Martin Marietta Corp., Denver, CO, Rept. No. NASA-CR-3143; MCR-78-581, 146 pp (June 1979) N79-26428

Key Words: Spacecraft, Booster rockets, Impedance, Frequency domain method

The technique presented is based on frequency domain analysis and eliminates the necessity of final eigensolution for coupled payload/booster systems. A demonstration of the technique using Titan flight data and a low frequency environment prediction for a Shuttle payload are included. Criteria and philosophy for the technique for future payloads is discussed.

80-60

Analysis and Test for Space Shuttle Propellant Dynamics (1/10th Scale Model Test Results). Volume 1: Technical Discussion

R.L. Berry, J.R. Tegart, and L.J. Demchak

Martin Marietta Corp., Denver, CO, Rept. No. NASA-CR-160244; MCR-79-560-Vol-1, 84 pp (May 1979) N79-25240

Key Words: Space stations, Aircraft, Propellants, Fluid-induced excitation

Space shuttle propellant dynamics during ET/Orbiter separation in the RTLS (return to launch site) mission abort sequence were investigated in a test program conducted in the NASA KC-135 'Zero G' aircraft using a 1/10th-scale model of the ET LOX Tank. Low-g parabolas were flown from which thirty tests were selected for evaluation. Data on the nature of low-g propellant reorientation in the ET LOX tank, and meausrements of the forces exerted on the tank by the moving propellant will provide a basis for correlation with an analytical model of the slosh phenomenon.

80-61

Analysis and Test for Space Shuttle Propellant Dynamics (1/10th Scale Model Test Results). Volume 2: 1/10th Scale Model Test Data

R.L. Berry, J.R. Tegart, and L.J. Demchak

Martin Marietta Corp., Denver, CO, Rept. No. NASA-CR-160245; MCR-79-560-Vol-2, 414 pp (May 1979) N79-25241

Key Words: Space stations, Aircraft, Propellants, Fluid-induced excitation

Thirty sets of test data selected from the 89 low-g aircraft tests flown by NASA KC-135 zero-g aircraft are listed in tables with their accompanying test conditions. The data for each test consists of the time history plots of digitalized data (in engineering units) and the time history plots of the load cell data transformed to the tank axis system. The transformed load cell data was developed for future analytical comparisons. There are 14 time history plots per test condition. The contents of each plot is shown in a table.

BIOLOGICAL SYSTEMS

HUMAN

(Also see No. 42)

80-62

Annoyance from Simulated Road Traffic Noise

K.B. Rasmussen

The Acoustics Lab., Technical Univ. of Denmark, DK-2800 Lyngby, Denmark, J. Sound Vib., 65 (2), pp 203-214 (July 22, 1979) 5 figs, 7 tables, 12 refs

Key Words: Traffic noise, Human response

A laboratory study was carried out to investigate the relation between road traffic noise and annoyance with special reference to the number of noisy events. Each noise condition lasted 30 minutes and consisted of pink noise which was shaped with respect to frequency and time in order to simulate cars and trucks passing by on a nearby road. Subjects were exposed to each noise condition in groups of five, after which their reactions were assessed by using a questionnaire. Various time-derivative-based annoyance prediction methods were also used.

80-63

Subjective Evaluation of Work Environment with Special Reference to Noise

E. Ohrstrom, M. Bjorkman, and R. Rylander

Dept. of Environmental Hygiene, Univ. of Gothenburg, Fack, S-400 33 Gothenburg, Sweden, J. Sound Vib., 65 (2), pp 241-249 (July 22, 1979) 3 figs, 5 tables, 7 refs

Key Words: Machinery noise, Human response

The presence of subjective noise annoyance was investigated among workers in a machine factory and a textile mill by using a questionnaire. The relation between annoyance due to noise and annoyance caused by other factors in the work environment was also investigated. The techniques used in the study could be applied to obtain further information on other industrial noise exposure criteria than hearing damage to serve as a basis for standards for annoyance.

80-64

Effects of Noise Frequency on Performance and Annoyance

K.F. Key

NASA Langley Research Ctr., Hampton, VA, Rept. No. NASA-TM-80107, 22 pp (June 1979)
N79-26781

Key Words: Human response, Noise (sound)

Using a complex psychomotor task performed for 50 minutes in the presence of low frequency noise, high frequency noise, or ambient noise, annoyance ratings were obtained for noises of various frequencies by the method of magnitude estimation.

80-65

A Study of the Available Evidence on Duration Effects on Comfort and Task Proficiency Under Vibration

M.J. Clarke

Dept. of Mech. Engrg., Univ. College of Swansea, Swansea SA2 8PP, UK, J. Sound Vib., 65 (1), pp 107-123 (July 8, 1979) 18 figs, 1 table, 22 refs

Key Words: Human response, Vibration tolerance

The experimental literature on time dependence effects relating to "reduced comfort" and to "fatigue/reduced proficiency" in the presence of vibration at levels appropriate to a range of transport situations is discussed.

80-66

Optimization of Ride Comfort of Motor Vehicles (Beitrag zur Optimierung des Fahrkomforts von Kraftfahrzeugen)

V. Voy
Eichenstrasse 4, 8724 Hausen, Automobiltech. Z., 81 (7/8), pp 34 350 (July/Aug 1979) 9 figs, 4 refs (In German)

Key Words: Ground vehicles, Automobiles, Ride dynamics, Human response

In this paper the relation between the vibration stress of the driver and the reduction of his driving capability is shown. The damping factor of a model on an analogue computer has been optimized with regard to maximum driving comfort; by objective estimation (filtering) and by subjective ratings of persons subjected to vertical vibrations. The newly developed method has shown good accordance with the subjective ratings.

MECHANICAL COMPONENTS

ABSORBERS AND ISOLATORS

80-67
Performance of Two-Stage Fan with Larger Dampers on First-Stage Rotor
D.C. Urasek, W.S. Cunnan, and W. Stevans
NASA Lewis Research Ctr., Cleveland, OH, Rept. No. NASA-TP-1399; E-8958, 81 pp (May 1979) N79-23967

Key Words: Dampers, Fans

The performance of a two stage, high pressure-ratio fan, having large, part-span vibration dampers on the first stage rotor is presented and compared with an identical aerodynamically designed fan having smaller dampers.

TIRES AND WHEELS

80-68
Effects of Load, Inflation Pressure and Tire Deflection on Truck Tire Noise Levels
R.D. Kilmer, M.A. Cadoff, D.E. Mathews, and C.O. Shoemaker, Jr.
National Bureau of Standards, Washington, D.C., Rept. No. NBSIR-78-1570, DOT-HS-803 874, 49 pp (Jan 1979)
PB-296 261/1GA

Key Words: Tires, Truck tires, Noise generation

SAE Recommended Practice J57a – Sound Level of Highway Truck Tires – specifies that the tests be made using tires inflated to the maximum inflation pressure and loaded to the maximum load as specified by the Tire and Rim Association (T&RA). However, if local load limits preclude the use of the maximum rated load, tests may be conducted using lower loads if the inflation pressure is adjusted either to maintain constant tire deflection or according to the T&RA load/inflation pressure tables. This report presents acoustic data that allows evaluation of the equivalency of these alternate conditions. In addition, laboratory data on the relationships between load, inflation pressure, and tire deflection are presented.

80-69
Analytical Tire Models for Dynamic Vehicle Simulation
K.M. Captain, A.B. Boghani, and D.N. Wormley
Analysis and Instrumentation Div., Foster-Miller Associates, Waltham, MA, Vehicle Syst. Dyn., 8 (1), pp 1-32 (Mar 1979) 10 figs, 3 tables, 20 refs

Key Words: Tires, Mathematical models, Cargo vehicles

Four basic tire models suitable for dynamic vehicle simulation are formulated. The models are compared through a six-degree-of-freedom nonlinear simulation of a cargo truck crossing rough ground. Guidelines are developed for the selection of an optimum tire model for a given dynamic vehicle simulation.

80-70
Flutter and Divergence Instabilities in Systems of Railway Wheelsets with Semi-rigid Articulation
A.H. Wickens
British Rail Res. & Dev. Division, Derby, UK, Vehicle Syst. Dyn., 8 (1), pp 33-48 (Mar 1979) 4 figs, 6 refs

Key Words: Railway wheels, Railroad trains, Flutter, Cornering effects, Articulated vehicles

For railway vehicles having coned wheels mounted on solid axles there is, in general, a conflict between stability of lateral deviations from the motion along the track and ability to steer round curves. However, certain configurations of three-axle vehicle can satisfy the requirement of perfect curving and for certain values of the system parameters are dynamically stable.

BLADES

80-71

An Approach for Estimating Vibration Characteristics of Nonuniform Rotor Blades

K.-W. Lang and S. Nemat-Nasser

Northwestern Univ., Evanston, IL, AIAA J., 17 (9), pp 995-1002 (Sept 1979) 3 figs, 6 tables, 25 refs

Key Words: Blades, Rotor blades, Flexural vibration, Torsional vibration, Method of new quotient

A method is presented for determining the vibration characteristics of a rotating blade whose cross-sectional dimensions or mechanical properties may vary sharply or even discontinuously along its length. The coupled flapwise bending, chordwise bending, and torsional vibration of the blade is analyzed by the method of the new quotient which is based on a variational statement proposed by Nemat-Nasser. In this approach, the nonuniform blade properties may be approximated by step (piecewise constant) functions. Two illustrative examples are given, and the results are compared with available experimental data and other numerical solutions.

80-72

The Fibre Composite Helicopter Blade. Part 1: Stiffness Properties. Part 2: Prospects for Aeroelastic Tailoring

E.H. Mansfield and A.J. Sobey

Royal Aircraft Establishment, Farnborough, UK, Aeronaut. Quart., 30 (2), pp 413-448 (May 1979) 9 figs, 9 refs

Key Words: Blades, Helicopters, Stiffness coefficients

In Part 1 expressions are derived for the coupled torsional, extensional and flexural stiffnesses of a fibre composite tube, such as a helicopter blade, which is subjected to torsion, longitudinal tension, chordwise and flapping bending moments and shear. The theory is an extension of Batho-Bredt engineering analysis and is valid for a cylindrical tube of arbitrary cross-section with an arbitrary circumferential distribution of fibre composite plies. Particular attention is paid to the coupling effects in which an asymmetric fibre lay-up results in a twisting of the tube under bending and/or tension. Consideration is also given to the influence on the stiffness characteristics of an initial twist in the tube. In Part 2 the analysis of Part 1 is developed numerically for tubes representative of GFRP blades. Static and dynamic aspects are considered which pave the way for aeroelastic tailoring studies of such blades.

80-73

Aerodynamic Excitation Forces of Axial Turbomachinery Blades Caused by the Interaction of Adjacent Cascades (Aerodynamische Erregungskrafte von Schaufelschwingungen in axialen Turbomaschinen infolge der Interferenz benachbarter Schaufelgitter)

W. Lienhart

Parlerstr. 67, D-7000 Stuttgart 1, Bundesrepublik, Deutschland, Ing. Arch., 48 (4), pp 239-258 (1979) 20 figs, 5 tables, 17 refs
(In German)

Key Words: Blades, Turbomachinery blades, Aerodynamic excitation

The unsteady blade forces and moments caused by the interaction of adjacent cascades are calculated in the approximation of incompressible plane unsteady potential flow. The vibration stimuli for a number of double cascade configurations are presented, and the influences of the axial clearance between the cascades, of the profile shape, of the different pitches of adjacent cascades, and of the ratio of peripheral speed to isentropic stage velocity are discussed. A simple formula is given for the influence of the axial clearance between the blade rows.

80-74

Shock Boundary Layer Interaction on High Turning Transonic Turbine Cascades

C.G. Graham and F.H. Kost

Rolls Royce Ltd., Bristol, UK, ASME Paper No. 79-GT-37

Key Words: Blades, Turbine blades, Wind tunnel tests

A cascade investigation into the influence of supersonic shocks on turbine blade performance is reported. Two different rotor profiles designed for the same duty were tested in the rectilinear cascade wind tunnel at DFVLR-AVA Goettingen. The importance of Schlieren optics flow visualization (including high-speed film to show the unsteady behavior of the flow) in evaluating the results is discussed.

BEARINGS

(See No. 180)

BELTS AND CONVEYORS

80-75

Transverse Vibration of a Moving Strip

H.M. Nelson
Dept. of Mech. Engrg., Univ. of Sydney, Sydney 2006, Australia, J. Sound Vib., 65 (3), pp 381-389 (Aug 8, 1979) 1 fig, 4 tables, 13 refs

Key Words: Moving strips, Flexural vibration, Natural frequencies, Mode shapes

Conditions are established for the generation of a wave pattern with stationary nodes by the superposition of plane waves propagating in a uniformly moving medium. These conditions are then used to derive a closed form expression for the natural frequencies and modes of vibration of a thin strip moving between fixed guides with zero tension and to define an algorithm to determine the natural frequencies and modes of vibration for a wide range of problems of a similar type. The thin strip under tension is used as an example.

GEARS

80-76

Dynamic Behavior of Planetary Gear (5th Report, Dynamic Increment of Torque)

T. Hidaka, Y. Terauchi, and K. Nagamura
Faculty of Engrg., Yamaguchi Univ., Tokiwa-Dai, Ube, Japan, Bull. JSME, 22 (169), pp 1017-1025 (July 1979) 16 figs, 10 refs

Key Words: Gears, Dynamic tests

An experimental investigation about the torque variation in a single-stage Stoeckicht planetary gear (Type 2K-H) constructed with spur gears is carried out.

80-77

Dynamic Behavior of Planetary Gear (6th Report, Influence of Meshing-Phase)

T. Hidaka, Y. Terauchi, and K. Nagamura
Faculty of Engrg., Yamaguchi Univ., Tokiwa-Dai, Ube, Japan, Bull. JSME, 22 (169), pp 1026-1033 (July 1979) 14 figs, 7 refs

Key Words: Gears, Dynamic tests

Experimental investigations about the dynamic load and the torque variation in two cases, in which the meshing-phases of each planet gear in a single-stage Stoeckicht planetary gear differ, are carried out.

LINKAGES

(Also see No. 197)

80-78

Shaking Force Balancing of Planar Linkages with Force Transmission Irregularities Using Balancing Idler Loops

C. Bagci
Dept. of Mech. Engrg., Tennessee Technological Univ., Cookeville, TN 38501, Mech. Mach. Theory, 14 (4), pp 267-284 (1979) 13 figs, 19 refs

Key Words: Linkages, Mechanism, Dynamic synthesis

The article first shows 4-, 6-, and 8-bar planar mechanisms with force transmission irregularities in which an unbalanceable shaking force is generated by a link or by a group of links that have connections to the fixed link through pairs permitting linear freedoms only. Complete shaking force balancing of such mechanisms with force transmission irregularities using the method of linearly independent mass vectors and the concept of balancing idler loops is presented. Design equations for the complete shaking force balancing of some 4-, 6-, and 8-bar mechanisms with force transmission irregularities are given. A numerical example is included.

80-79

Dynamic Synthesis of 2 Degrees-of-Freedom Flexibly Coupled Slider-Link Mechanism for Harmonic Motion or Function-Generation

A.C. Rao
Government Engrg. College, Ujjain (M.P.), India, Mech. Mach. Theory, 14 (4), pp 233-238 (1979) 1 fig, 1 table, 10 refs

Key Words: Dynamic synthesis, Mechanisms

A simple mechanism consisting of two sliding inputs and one output, the output slider being flexibly coupled, is presented in this paper. The mechanism can also be designed for time dependent motion. The displacement equation renders itself easily for optimal synthesis using the method of least-squares, etc. An example problem is included.

STRUCTURAL COMPONENTS

STRINGS AND ROPES

(See No. 94)

CABLES

80-80

Experimental Study of the Dynamics of Variable-Length Cable Systems

T.W. Ward
Graduate Aeronautical Labs., California Inst. of Tech., Pasadena, CA, Rept. No. GALCIT-HSWT-1129, CEL-CR-79.006, 58 pp (Apr 1979)
AD-A068 332/6GA

Key Words: Cables (ropes), Experimental data

Laboratory experiments on the dynamics of variable length cable systems are described. The prototype situation that these experiments simulate is the deployment of retrieval of a heavy object at sea. A winching mechanism attached to an electromechanical oscillator was mounted over a 65 ft. (20 m) deep tank of water. A mass suspended by elastic and inelastic cables was payed-out and reeled-in at specified velocities and accelerations while being oscillated in the vertical plane. Cable tension data are provided as a function of cable direction, length, velocity, acceleration, and the frequency and amplitude of the oscillator.

80-81

Analysis of Cable Structures

A.H. Peyrot and A.M. Goulois
Dept. of Civil and Environmental Engrg., Univ. of Wisconsin-Madison, WI 53706, Computers Struc., 10 (5), pp 805-813 (Oct 1979) 8 figs, 7 refs

Key Words: Cables (ropes), Dynamic structural analysis, Computer programs

A numerical procedure has been developed to analyze complex 3-dimensional assemblies of substructures and cables. The procedure is applicable to guyed towers, flexible transmission lines, cable roofs or mooring networks. The computer program, which has been developed to analyze these composite structures, accepts arbitrary loads on the substructures but restricts the loads on the cable elements to gravity, thermal, or fluid drag effects. The algorithm is built around an efficient cable element subprogram. The computer algorithm is discussed in detail, and the simplicity and efficiency of the formulation is demonstrated by several examples.

BARS AND RODS

80-82

The Effect of Trailing End Geometry on the Vibration of a Circular Cantilevered Rod in Nominally Axial Flow

M.W. Wambsganss and J.A. Jendrzejczyk
Components Technology Div., Argonne National Lab., Argonne, IL 60439, J. Sound Vib., 65 (2), pp 251-258 (July 22, 1979) 2 figs, 3 tables, 10 refs

Key Words: Rods, Cantilever beams, Fluid-induced excitation, Vibration damping

The effect of "trailing end" geometry on the vibration of a circular cantilevered rod in nominally axial water flow is reported. Eleven different trailing end geometries were tested. For each end goemetry, rms displacement response and damping were measured and are presented as functions of mean axial flow velocity. The various geometric end shapes are ordered according to their effectiveness in attenuating rod vibration.

80-83

Controlled Impact of a Finite Elastic Circular Rod on an Isotropic, Elastic Half-Space

R. Solecki
Dept. of Mech. Engrg., Univ. of Connecticut, Storrs, CT 06268, J. Acoust. Soc. Amer., 66 (2), pp 509-513 (Aug 1979) 5 figs, 7 refs

Key Words: Rods, Shock wave propagation

The wave propagation in an elastic circular rod following its impact on elastic half-space is investigated until the instant of separation. The motion of the far end of the rod is assumed to be controlled during the whole process. An approximated response of the half-space is used to calculate resulting deflections and stresses at the interface. These quantities are compared with the corresponding quantities due to the controlled impact on a rigid half-space.

BEAMS

80-84

Vibration of Beams Made of Variable Thickness Layers

S.R. Soni
Appl. Mathematics Section, Vikram Sarabhai Space Ctr., Trivandrum-695022, India, J. Sound Vib., 65 (1), pp 75-84 (July 8, 1979) 6 figs, 9 refs

Key Words: Beams, Variable cross section, Flexural vibration, Timoshenko theory

Free transverse vibrations of a beam composed of variable thickness layers are studied on the basis of Timoshenko shear theory. The differential equations governing the transverse motion of the beam are solved to determine the frequencies by using the quintic spline collocation technique. Frequencies and mode shapes for the first three modes of vibration are computed for various layer thicknesses of clamped and cantilever beams. For comparison, results also are obtained by the finite element method, which show a very good agreement. The results for the frequencies are presented in tables and those for the displacements are given in figures. The effect of layer taper variation on the parameters of interest is studied in detail for three-layer beams.

80-85

Finite Elements and Convergence for Dynamic Analysis of Beams

D. Budcharoentong and V.H. Neubert
King Mongkut's Institute of Tech., Bangkok 14, Thailand, Computers Struc., 10 (5), pp 723-729 (Oct 1979) 9 figs, 3 tables, 15 refs

Key Words: Beams, Finite element technique, Bernoulli-Euler method

Two different methods are considered for improving the accuracy of finite elements for calculation of dynamic response of the Bernoulli-Euler beam. One method involves a generalized-coordinate procedure in which quadratic displacement functions are used to formulate a non-consistent mass matrix. In the second approach, a lumped parameter model is developed by making the dynamic stiffness, or mechanical impedance, accurate at the connection points. The two finite elements developed are compared with the consistent mass model and a center-of-gravity lumped mass model. Of particular interest is the rate of convergence of natural frequencies and dynamic stiffness.

80-86

Approximate Dynamic Analysis of Timoshenko Beams and Its Application to Tapered Beams

K. Nagaya
Dept. of Mech. Engrg., Faculty of Engrg., Yamagata Univ., Yonezawa, Japan, J. Acoust. Soc. Amer., 66 (3), pp 794-800 (Sept 1979) 5 figs, 15 refs

Key Words: Beams, Timoshenko theory, Variable cross section

An approximate method of analysis for dynamic response problems of a Timoshenko beam is presented. The results for the beam are obtained by the addition of the solution for bending and rotatory motions and that for the shear motion by neglecting the inertia force of the shear motion. The result by this analysis compared with both exact results for Timoshenko and Euler-Bernoulli beams. As applications of this study, dynamic response problems of taper beams with moving load are solved by this method.

80-87

Crash Tests of Small Highway Sign Supports

H.E. Robb, Jr., K.C. Walker, and M.J. Effenberger
Texas A&M Research Foundation, College Station, TX, Rept. No. RF3254-3, 311 pp (Jan 1979)
PB-297 405/3GA

Key Words: Collision research (automotive), Guardrails, Experimental data

The report describes 22 full-scale crash tests conducted to evaluate the impact performance of widely used support systems for small roadside signs. Promising new support systems were also evaluated. All systems were of the single post type, with one exception. One system had a vertical post and a back brace. Also summarized are the results of recent crash tests sponsored by industry on small sign support systems.

CYLINDERS

80-88

Orthogonality of the Elastodynamic Eigenfunctions for a Cylinder of Arbitrary Cross-Section

W.B. Fraser

Dept. of Appl. Mathematics, The Univ. of Sydney, N.S.W., 2006, Australia, Mech. Res. Comm., 6 (4), pp 217-222 (Apr 1979) 9 refs

Key Words: Cylinders, Eigenvalue problems

Orthogonality relations for the radial eigenfunctions of an elastic, circular cylinder of arbitrary cross-section are obtained.

80-89

The Dynamics of Clusters of Flexible Cylinders in Axial Flow: Theory and Experiments

M.P. Paidoussis

Dept. of Mech. Engrg., McGill Univ., Montreal, Quebec, Canada, J. Sound Vib., 65 (3), pp 391-417 (Aug 8, 1979) 17 figs, 19 refs

Key Words: Cylinders, Flutter

This paper presents an outline of the theory for the dynamics of clusters of independently supported flexible cylinders in axial flow, and an extensive discussion of the behavior of such systems with increasing flow velocity, with special emphasis placed on the modal forms of free coupled motions of the cylinders and on the onset of instabilities. Results of an experimental study of the problem are also presented, involving systems of two, three or four cylinders supported at both ends and positioned symmetrically in the cylindrical test section of a water tunnel; experiments were conducted with different intercylinder gaps and support conditions.

FRAMES AND ARCHES

80-90

On the Importance of Cross-Sectional Flexibility on Gross Response

M.P. Kamat

Dept. of Engrg. Science & Mechanics, Virginia Polytechnic Inst. and State Univ., Blacksburg, VA 24061, Computers Struc., 10 (5), pp 831-832 (Oct 1979) 2 figs, 7 refs

Key Words: Framed structures, Impact response (mechanical), Mathematical simulation, Computer programs

Most nonlinear analyzers like ACTION and PLANS do not account for cross-sectional flexibility of thin-walled frame members. They do however, permit simulation of plastic hinges. Judging by the excellent correlation between theory and experiment, such analyzers appear quite adequate in predicting reasonably accurately gross response parameters of thin-walled frame structures even though they may undergo severe cross-sectional deformations.

MEMBRANES, FILMS, AND WEBS

80-91

Vibration of an Arbitrarily Shaped Membrane with Point Supports

K. Nagaya

Dept. of Mech. Engrg., Yamagata Univ., Yonezawa, Japan, J. Sound Vib., 65 (1), pp 1-9 (July 8, 1979) 3 figs, 2 tables, 15 refs

Key Words: Membranes, Vibration response, Waveguide analysis

A method for solving vibration problems of an arbitrarily shaped membrane on point supports is presented. The frequency equation is derived by the use of the exact solution of the equation of motion which includes terms representing the reaction forces of the point supports. Numerical calculations are carried out for an elliptical membrane with two point supports, and the non-dimensional natural frequencies are shown for various aspect ratios.

80-92
Measurements of Aerofoil Unsteady Stall Properties with Acoustic Flow Control
N.J. Moss
Engrg. Dept., Univ. of Cambridge, Cambridge CB2 1PZ, UK, J. Sound Vib., 65 (4), pp 505-520 (Aug 22, 1979) 12 figs, 21 refs

Key Words: Airfoils, Flutter, Fluid-induced excitation

The transient processes of stall growth and removal on a rigidly mounted aerofoil are investigated experimentally using sound to control the aerofoil stall. The dynamic stall is similar to that on a pitching aerofoil and includes the downstream passage of pressure perturbations across the aerofoil chord during stall and unstall.

PANELS

80-93
A Vector-Continuous Loading Concept for Aerodynamic Panel Methods
W.B. Kemp, Jr.
NASA Langley Research Ctr., Hampton, VA, Rept. No. NASA-TM-80104, 39 pp (May 1979)
N79-24956

Key Words: Panels, Aerodynamic loads

An approach to the reduction of discretization errors in aerodynamic panel methods is presented. The approach is based on preventing the occurrence of induced velocity singularities at panel slope discontinuities by maintaining continuity of the velocity jump vector across the panels. The approach was implemented in a two-dimensional incompressible panel method formulation and evaluated by application to several external and internal flow problems.

80-94
Chladni Patterns in Random Vibration
A.J. Langley and P.H. Taylor
Dept. of Engrg., Univ. of Cambridge, Cambridge CB2 1PZ, UK, Intl. J. Engr. Sci., 17 (9), pp 1039-1047 (1979) 5 figs, 2 refs

Key Words: Strings, Plates, Random excitation

The presence of Chladni-like patterns of enhanced response on both a taut string and a thin elastic plate under single point random excitation is demonstrated theoretically using a reverberation field method of analysis. The statistics of the wavefield for the plate are established.

PLATES
(Also see Nos. 170, 171)

80-95
Experimental Determination of Transverse Vibration Modes of Thin I-Shaped Plates
K. Maruyama and O. Ichinomiya
Dept. of Mech. Engrg., Hokkaido Inst. of Tech., 419-2, Teine-Maeda, Nishi-ku, Sapporo, 061-24, Japan, Exptl. Mech., 19 (8), pp 271-275 (Aug 1979) 8 figs, 4 refs

Key Words: Plates, Natural frequencies, Holographic techniques

The natural frequencies and the corresponding mode shapes of clamped thin I-shaped plates are experimentally determined by time-averaged holographic interferometry. The natural-vibration modes exceeding 200 were identified using the real-time method. The corresponding natural frequencies ranged from 172 to 5606 Hz. In addition, in the case of a rectangular plate, the experimental results were shown to be in good agreement with the theoretical ones.

80-96
Axially Symmetric Stability of a Completely Free Circular Plate Subjected to a Non-Conservative Edge Load
Z. Celep
Faculty of Engrg. and Architecture, Technical Univ., Istanbul, Turkey, J. Sound Vib., 65 (4), pp 549-556 (Aug 22, 1979) 4 figs, 15 refs

Key Words: Plates, Stability

This paper presents a study on the behavior of the vibration and stability of a two dimensional structure: i.e., a completely free circular plate subjected to non-conservative radial loading. The eigencurves and mode shapes of the circular plate are presented for various values of the non-conservativeness parameter. Some interesting conclusions concerning the behavior of a completely free plate are drawn from the analytical investigation of the solution of the problem and from the numerical calculations as well.

80-97

Vibration of a Rectangular Plate Supported at an Arbitrary Number of Points

J.G.M. Kerstens
Space Div., Fokker-VFW B.V., P.O. Box 7600, Schiphol-Oost, The Netherlands, J. Sound Vib., 65 (4), pp 493-504 (Aug 22, 1979) 3 figs, 9 tables, 10 refs

Key Words: Plates, Rectangular plates, Modal constraint method

A method is described for establishing the natural frequencies of a rectangular plate supported at points. The number and the location of these points may be completely arbitrary. The method is based on some extensions to the intermediate problem technique of Aronszjan and Weinstein through the use of finite sets of constraints. The method is called the modal constraint method.

80-98

Vibration Analysis of Polar Orthotropic Annular Discs

F. Ginesu, B. Picasso, and P. Priolo
Universita di Cagliari, 09100 Cagliari, Italy, J. Sound Vib., 65 (1), pp 97-105 (July 8, 1979) 3 tables, 9 refs

Key Words: Disks (shapes), Composite materials, Natural frequencies

With the aim of designing structural elements of filament wound composite materials, a first analysis of the vibrating modes of an annular orthotropic disc is performed. To check the reliability of both the analytical and experimental approach, a uniform steel disc was previously tested. Natural frequencies are computed by means of a finite element program, while the experimental analysis is based on real time and time average holographic interferometry. For orthotropic discs, whose material properties are generally difficult to determine, the holographic analysis of vibrations can be used as a complementary instrument for testing the material and detecting defects.

80-99

Axisymmetric Vibrations of Reinforced Annular Circular Plates Under Impulsive Loads

S.-I. Suzuki
Dept. of Aeronautics, Nagoya Univ., Nagoya, Japan, J. Sound Vib., 65 (1), pp 51-60 (July 8, 1979) 6 figs, 7 refs

Key Words: Circular plates, Plates, Impact shock

The dynamic behavior of an annular circular plate with a reinforced inner edge is investigated for the case in which the plate is subjected to a step impulsive load, radially or transversely. The reinforcing ring is assumed to be a concentrated mass and the fundamental equations of motion of the plate are solved by the Laplace transformation method. The relationships between the dimensions of plate and ring, and the maximum values of stresses and bending moments at the inner edge are obtained. The errors induced by the assumption are also studied, by comparing results with the plane stress solutions.

80-100

Transverse Vibrations of Circular Plates Having Non-uniform Edge Constraints

A.W. Leissa, P.A.A. Laura, and R.H. Gutierrez
Dept. of Engrg. Mechanics, Ohio State Univ., Columbus, OH 43210, J. Acoust. Soc. Amer., 66 (1), pp 180-184 (July 1979) 1 fig, 1 table, 14 refs

Key Words: Plates, Circular plates, Boundary value problems

In the present paper a general method is presented for dealing with supports having translational and rotational flexibilities which vary in an arbitrary manner around the boundary. The exact solution in polar coordinates of the differential equation of motion for the plate is then substituted into the elastic boundary conditions. The resulting infinite characteristic determinant is solved by successive truncation. Numerical results are obtained by the method described above and also by using the Ritz method with functions which approximate both the differential equation and the boundary conditions.

80-101

Vibrations of a Plate with an Elastic Constraint of Eccentric Circular Part

K. Nagaya
Dept. of Mech. Engrg., Faculty of Engrg., Yamagata Univ., Yonezawa, Japan, J. Acoust. Soc. Amer., 66 (1), pp 185-191 (July 1979) 9 figs, 2 tables, 10 refs

Key Words: Plates, Boundary value problems

In this paper, a method for solving vibration problems of a viscoelastic plate having an eccentric circular constraint is presented. The frequency equation in a complex form for

the plate with arbitrary shape is obtained. Numerical calculations are carried out for two cases of a circular plate with an eccentric circular stepped surface and a circular plate on an eccentric elastic foundation. The nondimensional natural frequencies and the logarithmic decrements are given for these plates.

80-102

A General Dirac Delta Function Method for Calculating the Vibration Response of Plates to Loads Along Arbitrarily Curved Lines

W. Soedel and D.P. Powder
Ray W. Herrick Labs., School of Mech. Engrg., Purdue Univ., West Lafayette, IN 47907, J. Sound Vib., 65 (1), pp 29-35 (July 8, 1979) 6 figs, 6 refs

Key Words: Plates, Vibration response

A general Dirac delta function description of line loads along arbitrarily curved lines is developed. It is used to solve several example problems that illustrate dynamic (or static) line loading: along a line parallel to a coordinate axis; along the diagonal; along any straight line; and along an arbitrarily curved line.

80-103

Vibration of Stiffened Skew Plates by Using B-Spline Functions

T. Mizusawa, T. Kajita, and M. Naruoka
Dept. of Construction Engrg., Daido Inst. of Tech., Hakusuicho-40, Nagoya, Japan, Computers Struc., 10 (5), pp 821-826 (Oct 1979) 7 figs, 10 refs

Key Words: Plates, Stiffened plates, Free vibration, Rayleigh-Ritz method

This paper presents a general procedure for calculating the free vibration of stiffened skew plates by the Rayleigh-Ritz method with B-spline functions as coordinate functions. The stiffened skew plates are modeled as the skew plate with a number of stiffening beams. The results are compared with existing values based on other numerical methods. Vibration characteristics of stiffened skew plates are also studied with changing the arrangements of stiffening beams, the stiffness parameters of beams, skew angle and aspect ratio.

80-104

Flexural Vibrations of Certain Full and Annular Composite Orthotropic Plates

J.B. Greenberg and Y. Stavsky
Dept. of Aeronautical Engrg., Technion--Israel Inst. of Tech., Haifa, Israel, J. Acoust. Soc. Amer., 66 (2), pp 501-508 (Aug 1979) 6 figs, 3 tables, 12 refs

Key Words: Plates, Composite structures, Orthotropism, Flexural vibration

The uncoupled equation of motion for the flexural displacement of an orthotropic composite circular plate having symmetric lamination is presented. A numerical method is employed to calculate the symmetric and nonsymmetric vibrational frequencies of full and annular composite plates subjected to a variety of boundary conditions. Effects produced by lamination interchange and fiber reversal are discussed. Finally, pinhole-center annuli are examined and, for a free inner edge, a comparison is made with corresponding full-plate frequencies.

80-105

Note on the Extensional Vibration of a Thin Isotropic Non-Homogeneous Circular Plate with a Central Hole

A. Mukhopadyay
Vill & P.O. Khanyan, Dist. Hooghly, West Bengal, India, Rev. Roumaine Sci. Tech., Mecanique, 24 (3), pp 507-513 (1979) 3 refs

Key Words: Plates, Hole-containing media, Hankel transformation, Laplace transformation

The new finite Hankel transform is used to find the displacement and stresses in a non-homogeneous circular plate with a central hole subjected to dynamic loading on the boundary of the hole and the edge of the plate, the loads being arbitrary functions of time and the plate being in a state of extensional vibration.

80-106

Transient Elasto-Dynamic Response of a Circular Crack in a Thick Plate Under Torsion

E.P. Chen
Systems Safety Technology, Div. 4442, Sandia Laboratories, Albuquerque, NM 87185, J. Pressure Vessel Tech., Trans. ASME, 101 (3), pp 207-209 (Aug 1979) 3 figs, 6 refs

Key Words: Plates, Cracked media, Elastodynamic response

The elasto-dynamic response of a thick plate under torsion is considered in this study. A penny-shaped crack is assumed to exist in the center of the plate such that the problem is axisymmetric in nature. The crack is pressurized suddenly along its surfaces resulting in transient conditions. This problem is also equivalent to that of sudden appearance of a crack in the loaded plate. Hankel and Laplace transforms are used to reduce the problem to the solution of a pair of dual integral equations. A numerical Laplace inversion routine is used to recover the time dependence of the solution. The dynamic stress intensity factor is determined and its dependence on time and geometry is discussed.

SHELLS

80-107

Isoparametric Finite Elements for Free Vibration Analysis of Shell Segments and Non-Axisymmetric Shells

P.A.T. Gill and M. Ucmaklioglu

Dept. of Engrg. Science, Univ. of Durham, Durham DH1 3LE, UK, J. Sound Vib., 65 (2), pp 259-273 (July 22, 1979) 7 figs, 7 tables, 17 refs

Key Words: Shells, Finite element technique, Turbine blades, Natural frequencies

In the study reported here, eight- and ten-mode elements have been employed to represent shells having geometries with sharp curvatures or with sharp corner connections. The effect of different numbers of integration points on the performances of these elements has been surveyed. The information obtained from this survey has been used in predicting the natural frequencies of an oval cross-section hollow shell and a hollow turbine blade.

80-108

The Vibrations and Radiated Noise Associated with a Constrained Spherical Shell in Response to a Turbulent Boundary Layer Excitation

J.M. Garrelick

Cambridge Acoustical Associates, Inc., 1033 Massachusetts Ave., Cambridge, MA 02138, J. Acoust. Soc. Amer., 66 (1), pp 284-290 (July 1979) 6 figs, 11 refs

Key Words: Shells, Spherical shells, Turbulence, Fluid-induced excitation

An analysis is presented of a constrained, fluid-loaded, thin spherical shell subjected to a random pressure field associated with a turbulent boundary layer (TBL) excitation. The constraint is modeled as an axisymmetric, radially oriented impedance ring and the TBL is defined in terms of a cross-spectral density. Numerical results are generated for the spectrum density of the shell response as well as for the associated radiated pressure field.

80-109

Response of a Rocket Motor to Transverse Blast Loading

N.J. Huffington, Jr. and H.L. Wisniewski

Ballistics Research Lab., Army Armament Res. & Dev. Command, Aberdeen Proving Ground, MD, Rept. No. ARBRL-TR-02144, AD-E430 215, 54 pp (Feb 1979)

AD-A068 464/7GA

Key Words: Solid propellant rockets, Shells, Blast loads, Computer programs

The effects of propellant inertia and of internal pressurization on the structural response of solid propellant rocket motors subjected to transverse air blast loading are investigated, both analytically and numerically. The numerical predictions were accomplished using the BRL versions of the PETROS 3.5 computer program, which employs the finite difference method to solve the equations governing finite amplitude elastoplastic response of thin shells. The response of a typical rocket motor configuration is calculated for the limiting situations of the bare motor case and of the motor case containing the complete propellant grain, each with no internal pressurization and with the pressurization resulting from propellant combustion.

80-110

Doubly Curved Membrane Shell Finite Element

C.S. Gran and T.Y. Yang

School of Aeronautical and Astronautical Engrg., Purdue Univ., West Lafayette, IN, ASCE J. Engr. Mech. Div., 105 (EM4), pp 567-584 (Aug 1979) 10 figs, 2 tables, 17 refs

Key Words: Shells, Finite element technique, Eigenvalue problems

The formulation and testing of a high-order doubly curved membrane shell finite element is presented. Specialized for application to shells of revolution, the element is defined by lines of principal curvature and allows a third-order mapping of the meridian. The in-plane displacement assumptions are complete bicubic. The functions are represented by products of one-dimensional first-order Hermite interpolation functions. The transverse displacement assumption is bilinear. Mixed displacement derivatives are condensed from the element stiffness matrix forming an element with 28 degrees-of-freedom. An eigenvalue analysis performed on the element stiffness matrix indicates that three rigid body modes are implicitly included.

The structural evaluation of auxiliary branch piping systems for the effects of a large loss-of-coolant-accident (LOCA) in the main coolant loop piping has been studied by Westinghouse for many nuclear steam supply systems. The criteria that have been developed to ensure safe shutdown of the reactor for this design basis event are presented. Analytical methods used to meet the above criteria, in accordance with the limits of Section III of the ASME Code, are discussed for two applications: dynamic elastic analysis of essential branch piping to the unbroken loop; and dynamic plastic analysis of branch piping, required to maintain structural integrity, to the broken leg of the broken loop.

RINGS

(See No. 29)

PIPES AND TUBES

80-111

Comparison of Steam Hammer Dynamic Testing with Analysis for Main Steam Piping

T.E. Bostrom

Bechtel Power Corp., San Francisco, CA, ASME Paper No. 79-PVP-22

Key Words: Piping systems, Steam hammer, Dynamic tests

This paper deals with the dynamic analysis and dynamic testing of main steam piping for the steam hammer effects. The paper addresses analytical modeling of the pressure transient and transient and determination of the piping response. Dynamic testing of the main steam piping for steam hammer effects is discussed.

80-112

Criteria and Associated Dynamic Elastic Plastic Analysis of Auxiliary Branch Piping for a Large LOCA

L.R. Balkey and E.R. Johnson

Westinghouse Electric Corp., Pittsburgh, PA, ASME Paper No. 79-PVP-26

Key Words: Nuclear reactor components, Piping systems, Dynamic structural analysis

DUCTS

80-113

Duct Noise Radiation Through a Jet Flow

H.E. Plumblee and P.E. Doak

Lockheed-Georgia Co., Marietta, GA 30063, J. Sound Vib., 65 (4), pp 453-491 (Aug 22, 1979) 11 figs, 53 refs

Key Words: Ducts, Noise generation

The radiation of internal (or core) noise for aircraft turbojet or turbofan engines is studied analytically. The geometry of a typical engine is simplified for analytical considerations to a hemispherical shell with a jet flow and internal sound emanating through a circular hole on the axis. A linearized theory is used to derive a flow modified spherical wave equation. A forced separation technique is used to produce a modified Legendre equation describing the angular variation of the acoustic radiation field. Then a numerical technique is described for obtaining a general field solution by progressively imposing continuity of pressure across hemispherical shells as the solution is marched from near field to the far field. In a companion paper, numerical results are presented and compared with experimental results from a test configuration identical to that described by the theory.

80-114

A Finite-Element Analysis of Sound Propagation in a Nonuniform Moving Medium

S.B. Dong and C.Y. Liu

Mechanics and Structures Dept., Univ. of California, Los Angeles, CA 90024, J. Acoust. Soc. Amer., 66 (2), pp 548-555 (Aug 1979) 11 figs, 18 refs

Key Words: Ducts, Elastic waves, Sound propagation, Finite element technique

The problem of sound propagation in shear flow with temperature gradient in a rectangular duct is studied by a finite-element method. The formulation leads to an eigensystem containing both symmetric and nonsymmetric matrices. A subset of eigenvalues and their corresponding eigenvectors is extracted from this eigensystem by means of a very efficient Block-Stodola iterative technique. Applications of this methodology to various flow problems are presented and comparison of the present results with those of other investigators are made.

80-115

An Analytical and Experimental Study of Sound Propagation and Attenuation in Variable-Area Ducts

A.H. Nayfeh, J.E. Kaiser, R.L. Marshall, and L.J. Hurst

Virginia Polytechnic Inst. and State Univ., Blacksburg, VA, Rept. No. NASA-CR-135392, 134 pp (Oct 1978)

N79-25845

Key Words: Ducts, Variable cross section, Noise reduction

The performance of sound suppression techniques in ducts that produce refraction effects due to axial velocity gradients is evaluated. A computer code based on the method of multiple scales is used to calculate the influence of axial variations due to slow changes in the cross-sectional area as well as transverse gradients due to the wall boundary layers. An attempt is made to verify the analytical model through direct comparison of experimental and computational results and the analytical determination of the influence of axial gradients on optimum liner properties.

80-116

A Finite Element Formulation of the Eigenvalue Problem in Lined Ducts with Flow

R.J. Astley and W. Eversman

Dept. of Mech. Engrg., Univ. of Canterbury, Christchurch, New Zealand, J. Sound Vib., 65 (1), pp 61-74 (July 8, 1979) 4 figs, 3 tables, 14 refs

Key Words: Ducts, Acoustic linings, Eigenvalue problems, Finite element technique

A finite element method is used to formulate the eigenvalue problem for a lined duct with flow. Either two dimensional or axially symmetric ducts with sheared flows can be studied, although the examples cited are two dimensional. The primitive variables of velocity and pressure are used with quadratic shape functions in each element.

BUILDING COMPONENTS

(Also see No. 206)

80-117

Cyclic Loading Tests of Masonry Single Piers. Volume 2: Height to Width Ratio of 1

S.J. Chen, P.A. Hidalgo, R.L. Mayes, R.W. Clough, and H.D. McNiven

Earthquake Engrg. Research Ctr., California Univ., Berkeley, CA, Rept. No. UCB/EERC-78/28, NSF/RA-780580, 188 pp (Dec 1978)

PB-296 212/4GA

Key Words: Building components, Piers, Masonry, Experimental data, Seismic response

This report presents the results of thirty-one cyclic, in-plane shear tests on fixed ended masonry piers having a height to width ratio of 1. These thirty-one tests form part of a test program consisting of eighty single pier tests. The test setup was designed to simulate the boundary conditions the piers would experience in a perforated shear wall of a complete building.

80-118

Simplified Analysis of Vertical Vibrations

J. Shiau

Bechtel Power Corp., Los Angeles, CA, ASCE J. Energy Div., 105 (EY2), pp 251-264 (Aug 1979) 5 figs, 1 table, 1 ref

Key Words: Building components, Seismic excitation, Vibration response

In this paper, simplified equations of vertical motion are derived in a general manner to include n modes of all subsystems. Two examples are included. The first example illustrates procedures used to set up the simplified equations of vertical motion, according to the general expressions derived in this paper. The second example shows the validity of the simplified analysis by comparing the results with the results from the finite element analysis.

80-119

Dynamic Characteristics of Coupled Shear Walls

A.K. Basu, A.K. Nagpal, R.S. Bajaj, and A.K. Guliana
Dept. of Civil Engrg., Indian Inst. of Tech., Delhi, India, ASCE J. Struc. Div., 105 (ST8), pp 1637-1651 (Aug 1979) 8 figs, 5 tables, 9 refs

Key Words: Walls, Mathematical models, Mode shapes, Parameter identification, Seismic excitation

The first three natural frequencies and the corresponding mode shapes for fixed-based coupled shear walls are presented. The wall is modeled as a continuum of uniform properties and the resulting sixth-order homogeneous differential equation in terms of lateral displacement is solved exactly using appropriate numerical methods. The results are presented for various combinations of the two non-dimensional parameters which between them incorporate all the geometric and material properties of the wall system.

80-120

The Stability of Partially Rigid Two-Dimensional Surfaces in Uniform Incompressible Flow

K. Shahrokh and C.H. Ellen
Dept. of Mathematics, Imperial College of Science and Tech., London SW7 2BZ, UK, J. Sound Vib., 65 (3), pp 339-351 (Aug 8, 1979) 5 figs, 1 table, 9 refs

Key Words: Structural members, Panels, Membranes, Dynamic stability, Fluid induced excitation, Damping effects

A theoretical analysis is made of the stability of a partially rigid two-dimensional surface embedded in the uniform flow of an incompressible inviscid fluid. Membranes, simply supported panels and clamped panels, attached at their leading and trailing edges to rigid flat extensions aligned with the undisturbed flow direction, are considered and numerical results are obtained by using the Galerkin method. Similar results are obtained for a cantilever panel attached to a leading edge rigid surface modeling the aerofoil or splitter plate used in experiments. The effects of structural damping are included where appropriate and comparisons made with other relevant theoretical and experimental results.

80-121

Response of Structures to Dynamic Loading

N. Jones
Dept. of Ocean Engrg., Massachusetts Inst. of Tech., Cambridge, MA, Rept. No. 79-2, 79 pp (Mar 1979) AD-A068 567/7GA

Key Words: Transverse shear deformation effects, Rotatory inertia effects, Structural members, Beams, Plates

This survey opens with some introductory comments on the response of structures subjected to large dynamic loads which cause plastic behavior. The rigid plastic method of analysis is then introduced, together with a few observations on the limitations and advantages of this simplified procedure. This is followed by a discussion of recent studies into the influence of transverse shear and rotatory inertia on the dynamic plastic stable response of beams and circular plates. The dynamic plastic buckling behavior of various structural members and an idealized model is then examined. The review closes with a discussion and some concluding remarks.

80-122

Dynamics and Stability of Plane Trusses with Gusset Plates

D.E. Beskos
Dept. of Civil & Mineral Engrg., Univ. of Minnesota, Minneapolis, MN 55455, Computers Struc., 10 (5), pp 785-795 (Oct 1979) 11 figs, 27 refs

Key Words: Trusses, Plates, Bars, Forced vibration, Free vibration

The effect of gusset plates on free and forced vibration and stability analyses of plane trusses is investigated. The gusset plates are considered to be finite joints possessing mass and rotational flexibility. The bars of the truss are assumed to be elastic Bernoulli-Euler beams with distributed mass. Axial deformation of the bars and the effect of a constant axial force on the bending stiffness are taken into account. On the basis of these assumptions element stiffness matrices are constructed and presented in detail. The general formulation and solution of stability and free and forced vibration problems of trusses is discussed. Examples are presented in detail which demonstrate the effect of the gusset plates on the behavior of trusses under static or dynamic loads.

DYNAMIC ENVIRONMENT

ACOUSTIC EXCITATION

(Also see Nos. 55, 56, 195)

80-123

Acoustic Driving of Rotor

H. Kanber, I. Rudnick, and T.G. Wang

NASA, Pasadena Office, CA, Rept. No. N79-20827/8, PAT-APPL-812-447, 4 pp (Feb 13, 1979)
PATENT-4 139 806

Key Words: Rotors, Acoustic excitation

Sound waves are utilized to apply torque to a body in an enclosure of square cross section, by driving two transducers located on perpendicular walls of an enclosure, at the same frequency but at a pre-determined phase difference such as 90 degrees. The torque is a first order effect, so that large and controlled rotational speeds can be obtained.

80-124

Rotor Redesign for a Highly Loaded 1800 Ft/Sec Tip Speed Fan. 1: Aerodynamic and Mechanical Design Report

J.M. Norton, U. Tai, and R.M. Weber
Pratt & Whitney Aircraft Group, East Hartford, CT, Rept. No. NASA-CR-159596; PWA-5523-42, 104 pp (Apr 1979)
N79-26055

Key Words: Rotors, Fans, Aerodynamic stability

A quasi three dimensional design system and multiple-circular-arc airfoil sections are used to design a fan rotor. An axisymmetric intrablade flow field calculation models the shroud of an isolated splitter and radial distribution.

80-125

An Evaluation of Linear Acoustic Theory for a Hovering Rotor

C.E.K. Morris, Jr., F. Farassat, and P.A. Nystrom
NASA Langley Research Ctr., Hampton, VA, Rept. No. NASA-TM-80059, 57 pp (May 1979)
N79-26881

Key Words: Rotors, Noise generation

Linear acoustic calculations are compared with previously reported data for a small-scale hovering rotor operated at high tip Mach numbers. A detailed calculated description of the distributions of blade surface pressure and shear stress due to skin friction is presented.

80-126

Low-Frequency Broadband Noise Generated by a Model Rotor

K.S. Aravamudan and W.L. Harris
Dept. of Aeronautics and Astronautics, Massachusetts Inst. of Tech., Cambridge, MA, J. Acoust. Soc. Amer., 66 (2), pp 522-533 (Aug 1979) 17 figs, 2 tables, 16 refs

Key Words: Rotors, Noise generation, Rotary wings, Helicopter rotors

The influence of free-stream turbulence in the low-frequency broadband noise radiation from model rotors is experimentally investigated. The turbulence was generated in the M.I.T. anechoic wind tunnel facility with the aid of biplanar grids of various sizes. The spectra and the intensity of the low-frequency broadband noise have been studied as a function of parameters which characterize the turbulence and of helicopter performance parameters.

80-127

On the Prediction of Impact Noise. II: Ringing Noise

E.J. Richards, M.E. Westcott, and R.K. Jeyapalan
Inst. of Sound and Vibration Research, Univ. of Southampton, Southampton S09 5NH, UK, J. Sound Vib., 65 (3), pp 419-451 (Aug 8, 1979) 35 figs, 2 tables, 12 refs

Key Words: Machinery noise, Noise prediction

The introduction of legislation regarding the limits of noise in factories has led to the need for the prediction of likely noise levels produced by a machine at the design stage. Part I was concerned with noise produced by impacting bodies due to the high surface accelerations during the contact period. Part II is concerned with the noise arising from the subsequent free vibration. The radiation efficiency of simple components having various modes of vibration is discussed and presented in the form of charts.

80-128

Development of Temporal Sampling Strategies for Monitoring Noise

R.E. DeVor, P.D. Schomer, W.A. Kline, and R.D. Neathamer
Univ. of Illinois at Urbana-Champaign, Urbana, IL 61801, J. Acoust. Soc. Amer., 66 (3), pp 763-770 (Aug 1979) 6 figs, 2 tables, 5 refs

Key Words: Urban noise

This paper addresses the problem of the estimation of the long-term (yearly) mean of the Community Noise Equivalent Level (CNEL) or day/night average sound level (L_{DN}). To assess the level of autocorrelation in the data, autoregressive-moving average (ARMA) models are developed for the noise data via the Dynamic Data System (DDS) approach to time series analysis. These models are then used to derive estimates of the sample mean variance and therefore to establish sampling strategies. The data used in this study were obtained from continuous monitoring at a number of sites in the vicinity of a busy Naval Air Station.

80-129

Status of Knowledge of Sonic Booms

D.J. Maglieri, H.W. Carlson, and H.H. Hubbard
NASA Langley Research Ctr., Hampton, VA, Rept. No. NASA-TM-80113, 20 pp (June 1979)
N79-24955

Key Words: Sonic boom

The status of sonic boom technology with emphasis on the recent research results is summarized. Included are definitions of the boom carpets, both primary and secondary, a discussion of existing experience with primary booms including the status of overpressure predictions and boom minimization methodology through airplane design, an indication of the boom waveforms and audibility, and a discussion of focus booms resulting from aircraft maneuvers as well as the effect of abnormal atmospheric conditions on these maneuver booms.

80-130

Noise Generation by Instabilities in Low Reynolds Number Supersonic Jets

G.L. Morrison and D.K. McLaughlin
Oklahoma State Univ., Stillwater, OK 74074, J. Sound Vib., 65 (2), pp 177-191 (July 22, 1979) 12 figs, 1 table, 34 refs

Key Words: Noise generation, Fluid-induced excitation

An experimental investigation of noise generation by instabilities in low Reynolds number supersonic air jets is performed. Sound pressure levels, spectra and acoustic phase fronts are measured with a traversing condenser microphone in the acoustic field of axisymmetric, perfectly expanded, cold jets of Mach numbers 1.4, 2.1, and 2.5.

80-131

Program in Acoustics

School of Engrg. & Appl. Science, George Washington Univ., Washington, D.C., Rept. No. NASA-CR-158660, 18 pp (May 31, 1979)
N79-24771

Key Words: Noise generation, Noise reduction, Aircraft noise

Relevant research projects conducted by faculty and graduate students in the general area of aeroacoustics to further the understanding of noise generation by aircraft and to aid in the development of practical methods for noise suppression are listed. Special activities summarized relate to the nonlinear acoustic wave theory and its application to several cases including that of the acoustic source located at the throat of a near-sonic duct, a computer program developed to compute the nonlinear wave theory, and a parabolic approximation for propagation of sounding in moving stratified media.

80-132

Acoustic Generation by Vibrating Bodies in Homentropic Potential Flow at Low Mach Number

K. Taylor
Aerodynamics Dept., Royal Aircraft Establishment, Farnborough GU14 6TD, UK, J. Sound Vib., 65 (1), pp 125-136 (July 8, 1979) 4 refs

Key Words: Noise generation, Vibrating structures

The author's transformation method for finding the acoustic field in steady homentropic potential flow at low Mach number is applied to acoustic generation by vibrating bodies. In order to get round the restriction of the method to acoustic propagation in a steady basic flow, the boundary condition on the vibrating body surface is transferred on to the mean position of that surface. The method is applied to a pulsating sphere and a juddering sphere without restriction on wave number.

80-133

Mean Square Pressure of a Transient Oscillator and Applications to Punch Press Noise

L.L. Koss
Dept. of Mech. Engrg., Monash Univ., Clayton, Victoria 3168, Australia, J. Sound Vib., 65 (1), pp 137-144 (July 8, 1979) 1 fig, 2 tables, 8 refs

Key Words: Noise generation, Presses

This paper considers the transient sound radiated by a perfect radiator and a pulsating sphere. The motions are governed by the free decay of a linear spring-mass-dashpot system. Predictions of the mean square pressure radiated by the above are then applied to the case of the sound radiated by a punch press.

80-134

Acoustic-to-Seismic Coupling; Properties and Applications to Seismic Sensors

M.D. Flohr and D.H. Cress

Army Engineer Waterways Experiment Station, Vicksburg, MS, Rept. No. WES-TR-EL-79-1, 150 pp (Feb 1979)

AD-A067 348/3GA

Key Words: Acoustic excitation, Acoustic signatures, Acoustic detection, Seismic detection

Acoustic-to-seismic coupling is investigated using measurements of acoustic and seismic signals generated from acoustic sources. Source types used for the measurements are pure tones, band limited pink and white noise, and broad band noise from an acoustic impulse (gun shot). Dependence of the coupling on source height is also investigated.

80-135

Fibrous Glass and Mineral Fiber Acoustical Materials

A. Eckel

Eckel Industries, Inc., Cambridge, MA, S/V, Sound Vib., 13 (7), pp 24-27 (July 1979) 3 figs, 1 table

Key Words: Acoustic absorption, Noise reduction, Glass, Fiber composites

The development of glass and mineral fiber materials for acoustical applications is reviewed. Typical product characteristics, acoustical testing procedures, typical applications, and acoustical performance ratings are discussed as well.

80-136

Acoustic High-Frequency Scattering by Elastic Cylinders

J.W. Dickey and H. Überall

David W. Taylor Naval Ship Res. & Dev. Center, Annapolis, MD 21402, J. Acoust. Soc. Amer., 66 (1), pp 275-283 (July 1979) 10 figs, 21 refs

Key Words: Cylinders, Acoustic scattering

Acoustic scattering from an infinite elastic cylinder in a fluid is described by using the Sommerfeld-Watson transformation. The wavenumbers for the surface and transmitted waves are determined by poles or saddle points, respectively, of the scattering amplitude in the complex wavenumber plane. Dispersion and attenuation curves for the dominant surface wave modes have been obtained from the pole positions and given in our previous work. The present study gives the amplitudes of all the known contributions to the scattered field by evaluating the corresponding residues and the saddle-point amplitudes.

80-137

Sound Transmission Loss of Ventilation Louvers

A.M. Teplitzky and J.P. Carlson

Consolidated Edison Co. of New York, Inc., New York, S/V, Sound Vib., 13 (8), pp 24-26 (Aug 1979) 8 figs, 5 refs

Key Words: Ventilation, Sound transmission loss

A series of laboratory sound transmission loss tests are performed on various types of metal and masonry louver systems. Louvers are tested to quantitatively determine the effects of blinding the "line-of-sight," forming a labyrinth, or double set of louvers separated by an air space between.

80-138

Acoustic Emission Spectral Calibration and Analysis

C.M. Scala and I.G. Scott

Aeronautical Research Labs., Melbourne, Australia, Rept. No. ARL-Mat-Note-125; AR-001-284, 16 pp (June 1978)

N79-24772

Key Words: Acoustic emission, Calibrating

An acoustic emission (AE) calibration system based on the use of a helium jet is described. Reasons for the choice of the helium jet are given. Various other simulated sources of AE are discussed in terms of their suitability for calibration of AE systems.

80-139

Statistical Evaluation of the Accuracy of External Sound Level Predictions Arising from Models

R. Bullen

Dept. of Architectural Science, Univ. of Sydney, Sydney, New South Wales 2006, Australia, J. Sound Vib., 65 (1), pp 11-28 (July 8, 1979) 11 figs, 10 refs

Key Words: Mathematical models, Sound pressure levels, Statistical analysis

In this paper, a number of modeling strategies, utilizing different amounts of information about the environment, are studied and their absolute accuracies determined.

80-140

A Ray Theory Model of Acoustic Interaction with the Ocean Bottom

S.K. Mitchell and J.J. Lemmon

Applied Research Labs., The Univ. of Texas at Austin, TX 78712, J. Acoust. Soc. Amer., 66 (3), pp 855-861 (Sept 1979) 13 figs, 15 refs

Key Words: Underwater sound, Sound reflection

A ray theory model of bottom interaction has been constructed, motivated by observations of "refracted arrivals". Plane wave reflection coefficients have been computed using ray theory to trace the ray paths in the bottom from an incident plane wave, and then applying the necessary boundary conditions at interfaces by treating each ray locally as a plane wave at the interfaces. Example results from the model are presented: bottom loss, 1/3-octave band averaged bottom loss, and the plane wave impulse response (Fourier transform of the plane wave reflection coefficient). The bottom loss results are compared to the results of exact (wave theory) approaches.

80-141

Numerical Solutions of Underwater Acoustic Wave Propagation Problems

D. Lee and J.S. Papadkis

New London Lab., Naval Underwater Systems Ctr., New London, CT, Rept. No. NUSC-TR-5929, 42 pp (Feb 25, 1979)
AD-A067 023/2GA

Key Words: Underwater sound

In this report, two accurate general purpose approaches are presented for the solution of variable coefficient parabolic wave equations. In a finite-difference approach, techniques are derived from both the conventional explicit and implicit schemes, and the associated convergence theory is thoroughly analyzed.

80-142

Derivation of the Acoustic Wave Equation in the Presence of Gravitational and Rotational Effects

J.A. DeSanto

Naval Research Lab., Washington, D.C. 20375, J. Acoust. Soc. Amer., 66 (3), pp 827-830 (Aug 1979) 11 refs

Key Words: Underwater sound, Elastic waves, Wave equation

The multidimensional partial differential equation obeyed by the underwater pressure field in the presence of gravitational and rotational forces acting on the fluid medium is derived. The result is valid for a sound speed which depends on all three spatial dimensions and time. The relationship to the internal wave equation is also presented, as well as other examples, including the effect of Rossby waves.

80-143

Mesoscale Variations in the Deep Sound Channel and Effects on Low-Frequency and Propagation

W.J. Emery, T.J. Reid, J.A. DeSanto, R.N. Baer, and J.P. Dugan

Dept. of Oceanography, Texas A&M Univ., College Station, TX 77843, J. Acoust. Soc. Amer., 66 (3), pp 831-841 (Aug 1979) 20 figs, 25 refs

Key Words: Underwater sound, Sound propagation

Spatial variability in the deep sound channel is measured in a large-scale oceanographic survey, and its effects on sound propagation are studied in a numerical experiment. The oceanographic data are obtained from a near-synoptic, multiship survey of upper layer thermal structure in the Northwest Pacific which is extended to 4000 m depth using an objective extrapolation model and historical hydrographic data. The extrapolated temperature profiles are converted to salinity and sound velocity profiles using mean temperature-salinity curves, and the resultant sound velocity structure is dominated by mesoscale features which are apparent as large vertical excursions of the channel depth.

80-144

Scattering from Oceanic Microstructure: Detection with a Large Aperture Array

G.T. Kaye and V.C. Anderson

Univ. of California, San Diego, CA 92152, J. Acoust. Soc. Amer., 66 (3), pp 842-849 (Aug 1979) 10 figs, 1 table, 23 refs

Key Words: Underwater sound, Acoustic scattering

A large aperture, high-frequency array with sound source has been used to detect returns from sound velocity microstructure. Returns were infinitely clipped and numerous beams were formed by steering for curved wave fronts. The processing was a unique application of digital array phasing that allowed discrimination between returns from reflectors and discrete point scatterers.

80-145

The Equivalence of Bottom Loss and Mode Attenuation Per Cycle in Underwater Acoustics

C.T. Tindle

Applied Research Labs., The Univ. of Texas at Austin, TX 78712, J. Acoust. Soc. Amer., 66 (1), pp 250-255 (July 1979) 3 figs, 12 refs

Key Words: Underwater sound, Elastic waves, Sound waves, Sound attenuation, Oceans

The attenuation of a normal mode in one mode cycle distance and the reflection loss of a plane wave incident on the ocean bottom at the equivalent ray angle are numerically found. The effect of a varying sound speed in the water and of changing the number of modes is examined. The results are used to derive a new invariant expression for the mode cycle distance.

80-146

Acoustic Propagation in Random Oceans Using the Radiation Transport Equation

H.L. Wilson and F.D. Tappert

Science Applications, Inc., 1200 Prospect St., P.O. Box 2351, La Jolla, CA 92038, J. Acoust. Soc. Amer., 66 (1), pp 256-274 (July 1979) 16 figs, 30 refs

Key Words: Elastic waves, Sound waves, Wave propagation, Oceans

A new theoretical approach to the modeling of acoustic propagation in randomly fluctuating oceans has been developed based on radiation transport equations which describe the evolution of the mutual coherence function of the acoustic pressure field. A general computer program has been developed to implement this theory for a large class of scattering models, including volume scattering by random internal waves and rough surface scattering by fully developed seas or long wavelength ocean swells. The radiation transport code at present deals with CW signals in two spatial dimensions and is used to calculate transmission loss. It has been applied to the problem of surface duct propagation with special emphasis on modeling the scattering out of the duct by random fluctuations and below-duct ensonification.

80-147

Inhomogeneous Waves and the Plane-Wave Reflection Coefficient

G.V. Frisk

Woods Hole Oceanographic Institution, Woods Hole, MA 02543, J. Acoust. Soc. Amer., 66 (1), pp 219-234 (July 1979) 15 figs, 1 table, 8 refs

Key Words: Underwater sound, Elastic waves, Sound waves, Wave reflection, Oceans

The theory of inhomogeneous plane-wave reflection is examined within the context of conservation of energy, and an expression for the intensity of these waves is derived. A general asymptotic result for R for large horizontal wavenumber is also derived. The computation of R for inhomogeneous waves is illustrated for three canonical bottom examples: impenetrable; isovelocity fluid; and isovelocity fluid layer overlying an isovelocity fluid half-space.

70-148

Beam Forming and Frequency Dependence of Mode Identification in Shallow Water Propagation

C. Gazanhes, J.L. Garnier, and J.P. Sessarego

Dept. of Acoustics, Centre National de la Recherche Scientifique, 13274 Marseille, France, J. Sound Vib., 65 (2), pp 165-176 (July 22, 1979) 12 figs, 2 tables, 7 refs

Key Words: Underwater sound, Sound waves, Wave propagation

A study of the possibilities of filtering the modes of propagation in the case of acoustical propagation in shallow water is described. The stability and the efficiency of the filtering of modes in the case of nonmonochromatic signals such as wave trains and bandpass filtered noise are considered.

SHOCK EXCITATION

80-149

Nuclear Damage to Point Target

C.S. Kelley, W.D. Scharf, S.E. Gehman, and J.H. Wasilik

Harry Diamond Labs., Adelphi, MD, Rept. No. HDL-TR-1876, 61 pp (Dec 1978)

AD-A067 184/2GA

Key Words: Nuclear explosion effects, Damage prediction, Nuclear weapons effects, Hardened installations, Equipment response

This report deals with the calculation of damage to dimensionally small battlefield items. This damage is caused by nuclear weapons deployed against other targets that may or may not be collocated with the small battlefield items. The report consists of two parts. The first part presents the unclassified results; the second (a supplement published under separate cover) presents the classified results.

80-150

Subcritical Excitation and Dynamic Response of Structures in Frequency Domain

A.M. Abdelrahman, C.B. Yun, and P.C. Wang

Dept. of Civil Engrg., Polytechnic Inst. of New York, 333 Jay St., Brooklyn, NY 11201, Computers Struc., 10 (5), pp 761-771 (Oct 1979) 7 figs, 6 tables, 11 refs

Key Words: Shock excitation, Earthquake resistant structures, Frequency domain method

The main objective of this paper is to explore the idea of the critical, subcritical excitations for the assessment and prediction of the earthquake resistance of structures using the frequency domain method. A technique for least-square fit of complex valued functions is also developed in this paper, to obtain the subcritical excitation. Results obtained in this study appear to be consistent with those obtained in the time domain method.

80-151

Seismic Restraint Spacing: A Velocity Spectrum Method and Other Considerations

M. Lee

Gilbert Associates, Inc., Reading, PA, ASME Paper No. 79-PVP-12

Key Words: Seismic response spectra

Monotonic spectra are defined and used to justify the validity of both acceleration and velocity spectrum methods in all frequency ranges. The effects of higher modes are theoretically derived in terms of the fundamental modes so that only the latter are used through constant multipliers to rigorously represent the SRSS responses of infinite modes.

80-152

On the Significance of Phase Content in Earthquake Ground Motions

Y. Ohsaki

Faculty of Engrg., Univ. of Tokyo, Tokyo, Japan, Intl. J. Earthquake Engr. Struc. Dynam., 7 (5), pp 427-439 (Sept/Oct 1979) 15 figs, 1 ref

Key Words: Ground motion, Seismic excitation

A number of problems relating to characteristics of harmonic phase angles contained in earthquake ground motions are discussed. The significance of the concept of phase differences in certain properties of earthquake ground motions is emphasized. A few applications of this new concept to earthquake engineering problems are illustrated as well.

80-153

Stress Wave Propagation in Bilayered Media

A.H. Nayfeh

NDE Branch, Air Force Material Lab., Wright-Patterson AFB, OH 45433, & Dept. of Aerospace Engrg. & Appl. Mech., Univ. of Cincinnati, Cincinnati, OH 45221, J. Acoust. Soc. Amer., 66 (1), pp 291-295 (July 1979) 6 figs, 9 refs

Key Words: Shock wave propagation

Integral transform techniques are utilized in order to analyze the propagation of spherical waves in bispherical elastic media. A typical model consists of a cavity located at the

center of a spherical material which in turn is embedded in an infinite medium of different properties. The inner surface of the cavity is loaded with a time dependent explosionlike pressure. Exact solutions are only possible to obtain for the special case of a single material and also for the arrival time (wave-front) regions. Solutions of the general bispherical model are obtained by inverting the transforms numerically.

80-154

Response of an Elastic Solid to Nonuniformly Expanding Surface Loads

A. Roy

Centre of Advanced Study in Applied Mathematics, Univ. of Calcutta, 92, A.P.C. Road, Calcutta-700 009, India, Intl. J. Engr. Sci., 17 (9), pp 1023-1038 (1979) 3 figs, 17 refs

Key Words: Shock wave propagation, Elastic media

Exact expressions are obtained for the displacement field in a homogeneous isotropic elastic half space whose surface is subjected to a unit normal pressure. The shock load emanates from a point and expands nonuniformly and radially outwards. The displacement field is obtained in the form of triple integrals over finite ranges. Both accelerating and decelerating loads are considered. Wave front surfaces with their regions of existence are identified. First motion approximations near different wave arrivals are obtained by a limiting process.

80-155

Propagation of Waves in a Fluid-Saturated Porous Elastic Solid

T. Levy

Departement de Mathematiques, Universite de Rouen, 76130-Mont Saint Aignan et L.A. No. .229 CNRS, France, Intl. J. Engr. Sci., 17 (9), pp 1005-1014 (1979) 9 refs

Key Words: Shock wave propagation, Elastic media, Porous materials, Fluid filled media

A theory is developed for the propagation of waves in a porous elastic solid containing a compressible viscous fluid using a homogenization process. The matrix is a lattice of periodically distributed gaps of arbitrary shape, the period of the lattice being small compared with the wave length. The present treatment is concerned with materials where fluid and solid are of comparable densities. Two cases are considered: the situation in which the pores are connected and that in which they are not. When pores are closed, the bulk medium behaves like an elastic medium; when they are connected, the fluid filtration and the bulk deformation are coupled. Boundary conditions, for macroscopic variables, at the interface between such a porous medium and the adjacent free flow are given.

VIBRATION EXCITATION

(Also see No. 185)

80-156

Random Vibration Introduction: Environments, Damaging Effects, Tests, Test Specifications and Test Economy

B. Bang, B.B. Petersen, and E. Moerup

Danish Research Ctr. for Applied Electronics, Hoersholm, Denmark, Rept. No. ECR-84, 64 pp (Sept 1978)

N79-26435

Key Words: Random vibration, Vibration tests

The random vibration signal and the character of the random vibration environment are explained briefly and some questions connected to the performance of random tests are discussed. Responses of structures to random vibration are treated from a practical and theoretical point of view. The effect of a random vibration test on some equipment is compared to that of a sinusoidal vibration test. The possibilities of converting sine vibration test requirements into random vibration test specifications are discussed. The economy of sinusoidal and random vibration tests was compared. In support of suggestions and explanations, analyses of actual vibration environments were performed with respect to signal character.

MECHANICAL PROPERTIES

FATIGUE

(Also see No. 153)

80-157

A Model for the Fatigue in Elastic Materials with Frequency Independent Q

M. Caputo

Istituto di Fisica "G. Marconi", Universita di Roma, Rome, Italy, J. Acoust. Soc. Amer., 66 (1), pp 176-179 (July 1979) 4 figs, 9 refs

Key Words: Fatigue, Elastic media

The phenomenon of the fatigue in elastic materials is represented by introducing a derivative of real order in the stress-strain relation. This model allows estimation of the number of cycles which would give the fatigue as function of the maximum strain applied and of its frequency.

80-158

Finite Element Analysis of Fatigue Crack Growth Under Random Loading

H.S.H. Alawi

Ph.D. Thesis, The Univ. of Arizona, 207 pp (1979) UM 7917340

Key Words: Fatigue life, Crack propagation, Finite element technique

The fatigue crack growth behavior is studied. The plastic deformation at the crack tip is considered using a new elasto-plastic approach. Complex constituent relations for material behavior under monotonically increasing load or cyclic loading are replaced by a probabilistic approach in the developed finite element program. Elastic-perfectly plastic constituents, each with a random yield strength, modeled by a normal probability density function are used. The changing boundary conditions due to the crack surface closure, opening, and growth are also taken into account. Narrow-band random loads with peaks having the Rayleigh probability density function are generated on a computer. The findings on crack tip behavior under cyclic loading are reported.

ELASTICITY AND PLASTICITY

80-159

Low-Frequency Expansions for Acoustic Wave Scattering Using Waterman's T-Matrix Method

V.V. Varadan and V.K. Varadan

Dept. of Engrg. Mechanics, Ohio State Univ., Columbus, OH 43210, J. Acoust. Soc. Amer., 66 (2), pp 586-589 (Aug 1979) 13 refs

Key Words: Elastic waves, Wave diffraction

Analytical expressions are derived for the T-matrix elements of cylindrical and spheroidal inclusions and cavities. For plane monochromatic acoustic wave incidence, analytical expressions are presented for the farfield scattered amplitude. These expressions are compared with existing, exact results using Mathieu functions and spheroidal functions.

80-160

A Magnetoelastic Strange Attractor

F.C. Moon and P.J. Holmes

Dept. of Theoretical and Appl. Mechanics, Cornell Univ., Ithaca, NY 14853, J. Sound Vib., 65 (2), pp 275-296 (July 22, 1979) 13 figs, 26 refs

Key Words: Magnetoelasticity, Oscillators

Experimental evidence is presented for chaotic type non-periodic motions of a deterministic magnetoelastic oscillator. These motions are analogous to solutions in non-linear dynamic systems possessing what have been called "strange attractors". In the experiments, a ferromagnetic beam buckled between two magnets undergoes forced oscillations. The driving amplitude and frequency parameters required for these non-periodic motions are determined experimentally. A continuum model based on linear elastic and non-linear magnetic forces is developed. Both experimental and theoretical evidence for the existence of a strange attractor in a deterministic dynamical system is presented.

80-161

Dynamic Elasto-Plastic Analysis of a Simple System

G.J. O'Hara and R.L. Bort

Naval Research Lab., Washington, D.C. 20375, Rept. No. NRL-MR-3838; AD-E000 241, 34 pp (Aug 1978)

AD-A068 469/6GA

Key Words: Elastoplastic properties

Six design categories were applied to design a three-bar structure connecting two rigid masses. The structure was taken as redundant, made of an elasto-plastic material, and required to resist dynamic loads applied independently from two directions. Weight and deformations of the structures are compared.

EXPERIMENTATION

MEASUREMENT AND ANALYSIS

80-162

Automated Dynamic Young's Modulus and Loss Factor Measurements

W.M. Madigosky and G.F. Lee

Naval Surface Weapons Ctr., White Oak, Silver Spring, MD 20910, J. Acoust. Soc. Amer., 66 (2), pp 345-349 (Aug 1979) 11 figs, 3 tables, 5 refs

Key Words: Measuring instruments, Modulus of elasticity, Acoustic absorption

A progressive wave apparatus featuring an automated data processor is described. As illustrations of the technique, measurements were made on three rubber compounds: a polyurethane, a neoprene, and a nitrile rubber.

80-163

Notes on the Transient Response and Errors of Shock Accelerometers with Second-Order Filters

W.R. MacDonald

Royal Aircraft Establishment, Farnborough, UK, Rept. No. RAE-TM-IT-179, DRIC-BR-66839, 29 pp (Jan 1979)

AD-A068 776/4GA

Key Words: Accelerometers, Transient response

The response of accelerometers, with second-order filters, is considered for acceleration pulses. The time history of their integrated (velocity) response is also treated. Graphs relating the error in measuring peak acceleration to the filter parameters are given, and the results are related to practical situations experienced when calibrating accelerometers in RAE. The effect of accelerometer non-linearity when calibrating by velocity-change methods is briefly investigated and a method of measuring the non-linearity is suggested.

80-164

Measuring and Analyzing Vibration

T.F. Meinhold

Plant Engrg., 32 (21), pp 82-91 (Oct 4, 1979) 11 figs, 2 tables

Key Words: Vibration measurement, Measuring instruments

In the article, an overview of instrument types and capabilities plus expert opinions on their selection, use, and care is described.

80-165

Determination of True Cutting Signal by Separation of Instrumentation Dynamics from Measured Response

E. Garcia-Gardea, F.A. Burney, and S.M. Wu

Mecanica ITESM Su[illegible] J., Monterrey, Mexico, J. Engr. Indus., Trans. ASME, 101 (3), pp 264-268 (Aug 1979) 6 figs, 1 table, 8 refs

Key Words: Dynamometers, Calibrating

The Dynamic Data System (DDS) methodology is used for the separation of the cutting signal from the dynamics of a dynamometer. A sixth order continuous Autoregressive Moving Average model is fitted to a milling machine's cutting force signals. The dynamics of the dynamometer are separated as a second order model and the true milling signals are constructed using the resultant parameters of a fourth order model.

80-166

Improving the Accuracy of Structural Response Measurements -- Part I

J.O. Litz

Hewlett-Packard, Santa Clara Div., Santa Clara, CA, Test, 41 (4), pp 6-13 (Aug/Sept 1979) 9 figs

Key Words: Vibration measurement, Frequency response method, Error analysis

In the article, identification and correction of mass loading, and accelerometer loading errors are discussed.

80-167

Compact Parametric Hydrophone Using Nonlinear Interaction within a Cylindrical Rubber Waveguide

R.D. Corsaro and J. Jarzynski
Naval Research Lab., Washington, D.C. 20375, J. Acoust. Soc. Amer., 66 (3), pp 895-904 (Sept 1979) 12 figs, 9 refs

Key Words: Underwater sound, Hydrophones

This paper investigates the effects of placing a rubber cylinder between the pump and receiving transducers in an otherwise conventional parametric receiver. A theoretical model of this configuration is developed, using the numerical solution of the system of equations obtained by coupling the interior surface Helmholtz equation to the integral equation for the exterior of the cylinder.

80-168

Limitations and Corrections in Measuring Structural Dynamics

P.L. Walter and H.D. Nelson
Sandia Labs., Albuquerque, NM 87185, Exptl. Mech., 19 (9), pp 309-316 (Sept 1979) 6 figs, 8 refs

Key Words: Measurement techniques, Dynamic properties

This work deals with limitations encountered in measuring the dynamic characteristics of structural systems. Structural loading and response are measured by transducers that are characterized by multiple resonant frequencies where peaks occur in the magnification factor of their transfer function. The transfer function of a transducer is the ratio of the Fourier transform of its output to the Fourier transform of the input causing that output. The magnification factor of the transfer function of a transducer is the factor by which its zero-frequency response must be multiplied to determine the magnitude of its steady-state response at any given frequency.

80-169

Static and Dynamic Frequency-Temperature Characteristics of Quartz Vibrators

A. Ballato
Electronics Technology/Devices Lab., Army Electronics Res. and Dev. Command, Fort Monmouth, NJ, Rept. No. DELET-TR-79-8, 33 pp (Apr 1979) AD-A068 630/3GA

Key Words: Quartz resonators

The maximum frequency excursion has been computed for the AT and SC cuts of quartz in terms of the static frequency-temperature parameters as functions of orientation angle.

80-170

Vibrations of Quartz Plates with the HP-67 Pocket Calculator

R.D. Mindlin
89 Deer Hill Dr., Ridgefield, CT 06877, Computers Struc., 10 (5), pp 751-759 (Oct 1979) 1 fig, 12 refs

Key Words: Plates, Quartz resonators, Flexural vibration

Two mathematical solutions of a problem of coupled thickness-shear and flexural vibrations of the AT-cut quartz plate, with a pair of parallel, free edges, are presented. In one, the dispersion relation for waves in an infinite plate is approximated by a biquadratic equation. In the other, the exact transcendental equation is employed for the infinite plate and no approximation is introduced until the setting of the edge conditions. Calculations of frequency vs. dimensions for both methods are programmed for the HP-67 pocket calculator.

80-171

Thickness-Shear Vibrations of a Beveled AT-Cut Quartz Plate

B.K. Sinha and D.S. Stevens
Dept. of Mech. Engrg., Aeronautical Engrg. & Mech., Rensselaer Polytechnic Inst., Troy, NY 12181, J. Acoust. Soc. Amer., 66 (1), pp 192-196 (July 1979) 5 figs, 16 refs

Key Words: Plates, Quartz resonators, Normal modes

Thickness-shear vibration modes of a beveled AT-cut quartz plate are analyzed from an equivalent three-dimensional equation of motion. This equation is applied in the analysis of plano-convex contoured quartz crystal resonators and is derived from the dispersion relation obtained in the course of an investigation on overtone modes of coupled thickness-shear and thickness-twist vibrations of trapped energy resonators with rectangular electrodes. Calculations based on the analysis have been shown to have excellent agreement with experimental results.

DYNAMIC TESTS

(Also see Nos. 58, 59, 60, 61, 183)

80-172

Development and Use of Seismic Shock Test Criteria for Essential Equipment in Critical Facilities

P.N. Sonnenburg and J.D. Prendergast

Construction Engrg. Res. Lab. (Army), Champaign, IL, Rept. No. CERL-TR-M-236, 99 pp (Apr 1979) AD-A068 295/5GA

Key Words: Testing techniques, Equipment response, Seismic excitation, Earthquake resistant structures

This report provides procedures for establishing seismic qualification test criteria for essential equipment in critical facilities and presents guidance for interpretation of the test results. Existing data from proof and fragility tests on tactical support equipment were reviewed to analyze failure characteristics. The failure data were organized so they could be statistically analyzed to provide estimates of the probability of failure. The major tasks in the seismic test qualification of equipment are summarized: these tasks include test criteria formulation, test facility selection, test unit formulation, establishment of test qualification requirements, and interpretation of test results.

80-173

An Introduction to Dynamic Derivates. 2: The Equations of Motion for Wind Tunnel Pitch-Yaw Oscillation Rigs

G.F. Forsyth

Aeronautical Research Labs., Melbourne, Australia, Rept. No. ARL-Aero-Note-377; AR-001-296, 22 pp (Aug 1978)
N79-23982

Key Words: Wind tunnels, Test stands

The equations of motion are developed for a simplified free flight pitch-yaw system and for spring-mounted and rigidly-driven wind tunnel systems. For the spring-mounted system both initial displacement and forced-oscillation conditions are examined. A simplified cable towed system is also derived.

80-174

Use of Adjacent Jets to Investigate the Aerodynamic Sound of Airfoils at Moderately High Reynolds Numbers

H. Arbey, M. Sunyach, and G. Comte-Bellot

Laboratoire de Mecanique des Fluides, An Associated Lab. of the Centre National de la Recherche Scientifique, Ecole Centrale de Lyon, 69130 Ecully, France, J. Sound Vib., 65 (2), pp 215-228 (July 22, 1979) 15 figs, 17 refs

Key Words: Airfoils, Noise generation, Testing techniques

A new experimental set-up is proposed to investigate the noise generated by airfoils. It consists of two adjacent plane jets ducted into an anechoic room, and the airfoils under investigation are placed in the median jet.

DIAGNOSTICS

80-175

Application of Vibration Signals to the Identification of Hydrodynamic Instabilities in a Heated Channel

T.M. Romberg and R.W. Harris

Engrg. Research Div., Australian Atomic Energy Commission Research Establishment, Lucas Heights, New South Wales, 2232 Australia, J. Sound Vib., 65 (3), pp 329-338 (Aug 8, 1979) 8 figs, 15 refs

Key Words: Diagnostic techniques, Vibration signatures, Spectrum analysis, Boilers

Hydrodynamic and vibration measurements have been used to detect parallel channel, density wave and acoustic oscillations in the boiling flow through a heated channel. Multivariate spectral analysis theory is used to identify the influence of wall temperature, coolant flow and channel pressure drop on the wall vibrations as monitored by accelerometers in a back-to-back configuration. Such monitoring has diagnostic applications, and is an invaluable aid for the efficient operation of heat transfer plant.

80-176

On the Extraction and Filtering of Signals Acquired from Rotating Machines

S.G. Braun and B.B. Seth

Ford Motor Co., Dearborn, MI 48121, J. Sound Vib., 65 (1), pp 37-50 (July 8, 1979) 8 figs, 11 refs

Key Words: Rotors (machine elements), Diagnostic techniques, Acoustic signatures, Time domain method

The presentation of time domain signals acquired from rotating machines can be important for diagnostic applications involving signature analysis. Efficient methods are presented for extracting and filtering such periodic signatures. The procedures are based on leakage free data sampling. In conjunction with various windows, a new procedure for the suppression of strong interferences is presented, and simple design formulae for this developed. Experimental examples are given for signals acquired from a combustion engine.

80-177

Torsional Vibrations - Identification and Correction

R.L. Eshleman

Vibration Institute, 101 W. 55th St., Clarendon Hills, IL 60514, Machinery Vibration Monitoring and Analysis Seminar, Proc., Feb 13-15, 1978, Houston, TX, 27 pp

Key Words: Diagnostic techniques, Rotors (machine elements), Torsional vibrations

This presentation is concerned with torsional vibrations of rotating machine systems -- causes and correction. Measurement, analysis, and calculation of torsional natural frequencies and response are discussed in conjunction with sources of excitation and methods of control. Examples of operating machinery are used to illustrate the concepts presented.

80-178

Effects of Misalignment on Machinery

R.L. Eshleman

Vibration Institute, 101 W. 55th St., Clarendon Hills, IL 60514, Machinery Vibration Monitoring and Analysis Seminar, Proc., Feb 13-15, 1978, Houston, TX, 17 pp

Key Words: Diagnostic techniques, Rotors (machine elements), Alignment

Critical speeds, bearing instabilities and unbalanced mass response are phenomena that can be handled in the design and manufacturing stages of machine building. Alignment must be provided during installation; however, precautions can be observed such as proper coupling selection and plans and provisions for alignment during installation. Misalignment of equipment can be mechanically, thermally, or structurally induced. Thermal distortion of structures due to operational function; compliant foundations and structures that dynamically deform; and unstable, settling soils cause alignment problems.

80-179

Vibration Envelope Detection and Analysis Techniques

D.S. Wilson

Shaker Research Corp., Ballston Lake, NY 12019, Machinery Vibration Monitoring and Analysis Seminar, Proc., Feb 13-15, 1978, Houston, TX, 3 pp

Key Words: Diagnostic techniques

This article reports on vibration envelope detection and analysis techniques.

80-180

Determination of Antifriction Bearing Condition by Spectral Analysis

J.I. Taylor

Gardinier, Inc., U.S. Phosphoric Products, P.O. Box 3269, Tampa, TL 33601, Machinery Vibration Monitoring and Analysis Seminar, Proc., Feb 13-15, 1978, Houston, TX, 40 pp

Key Words: Diagnostic techniques, Antifriction bearings, Spectrum analysis

This paper describes procedures for identifying defects in antifriction bearings from analyses of the low frequencies (up to 2,000 Hz) generated by the moving parts in the bearing. Defects on bearing raceways, the cage, or rolling elements, as well as excessive clearance, cause unique vibration signals. A unique signal is also generated when bearings need lubrication. The spectrum shape, frequency, amplitude, and sum and difference frequencies are useful in identifying combinations of defects and their size. Information as to whether the bearing is in a thrust or radial loaded condition is presented.

80-181
Automated Machinery Surveillance and Diagnostics
D.S. Wilson and J.L. Frarey
Shaker Research Corp., Ballston Lake, NY 12019, Machinery Vibration Monitoring and Analysis Seminar, Proc., Feb 13-15, 1978, Houston, TX, 11 pp

Key Words: Diagnostic techniques, Machinery, Nuclear power plants, Computer-aided techniques

One approach toward improving the availability of nuclear power plant machinery is by continuously monitoring and analyzing the vibrational characteristics of critical machines. Through proper analysis of the vibrational characteristics, it is possible to detect impending problems before failure occurs and probable causes of failures if they do occur. This permits improved scheduling of outages, reduction of downtimes and maintenance costs.

80-182
Selecting Shaft Vibrational Amplitude Limits
D.S. Wilson
Shaker Research Corp., Northway 10 Executive Park, Ballston Lake, NY 12019, Machinery Vibration Monitoring and Analysis Seminar, Proc., Feb 13-15, 1978, Houston, TX, 4 pp

Key Words: Diagnostic techniques, Vibration measurement, Shafts

The most general standard vibration measurement is usually provided in velocity terms and measured unfiltered on the housing. This overall vibration level is the best indication of the total energy transmitted to the system. The difficulty in using the recommended published limits as a general rule is due to the difficulty of estimating the impedance between the driving source and the pickup location. Because of this, service factors are applied to the readings that are typical of experience for machinery types. This area is encompassed in subsequent Tech Briefs.

BALANCING

80-183
Design and Application of a Test Rig for Super-Critical Power Transmission Shafts
M. Darlow and A. Smalley
Mechanical Technology Inc., 968 Albany-Shaker Rd., Latham, NY 12110, Rept. No. NASA-CR-3155, 166 pp (Aug 1979)

Key Words: Test stands, Power transmission systems, Shafts, Balancing techniques

This report describes the design, assembly, operational checkout and application of a test facility for testing supercritical power transmission shafts under realistic conditions of size, speed, and torque. Alternative balancing methods and alternative damping mechanisms are demonstrated and compared. The influence of torque upon the unbalance distribution is studied, and its effect on synchronous vibrations is investigated. The facility has been demonstrated to be valuable for shaft system development programs and studies for both advanced and current-production hardware.

ANALYSIS AND DESIGN

ANALOGS AND ANALOG COMPUTATION

80-184
Elastic-Plastic Oscillators Under Random Excitation
R.L. Grossmayer
II. Institut f. Mechanik, Technische Universität Wien, A-1040 Vienna, Austria, J. Sound Vib., 65 (3), pp 353-379 (Aug 8, 1979) 16 figs, 27 refs

Key Words: Simulation, Elastic plastic properties, Oscillators, Random excitation

In order to compute the main response quantities, such as the yielding increment, the permanent set, the dissipated energy and the crossing rates, a so-called two-state approach is suggested. With the separation between the elastic and plastic parts of the response kept as originally proposed by Karnopp and Scharton, one linear equation is obtained for each state. The fundamental step then is to set up a conditional probability density for the plastic state variable under Gaussian stationary or non-stationary white noise excitation.

ANALYTICAL METHODS

(Also see No. 88)

80-185

On the Mean Square Stability of a Class of Nonstationary Coupled Partial Differential Equations

G. Ahmadi

Dept. of Mech. Engrg., Shiraz Univ., Shiraz, Iran,
Ing. Arch, 48 (4), pp 213-219 (1979) 19 refs

Key Words: Random excitation, Stability

The stability of the equilibrium solution of a class of coupled partial differential equations with nonstationary random coefficients is studied. Several theorems in regard to mean square stability of the equilibrium state of the system are established. Some examples of the applications of the results to engineering problems are presented and significant improvements on stability region are observed.

80-186

On the Accuracy of Mode Superposition Analysis in Structural Dynamics

O.E. Hansteen

Norwegian Geotechnical Inst. (NGI), Oslo, Norway,
Intl. J. Earthquake Engr. Struc. Dynam., 7 (5), pp 405-411 (Sept/Oct 1979) 7 figs, 1 table, 4 refs

Key Words: Modal superposition method

A technique is described for calculating the static contribution from the higher modes; the total response is then represented by the sum of the lower mode dynamic response and the higher mode static effects. The effectiveness of the procedure is demonstrated by a numerical example.

80-187

Robust Stability of Linear Systems: Some Computational Considerations

A.J. Laub

Lab. for Information and Decision Systems, Massachusetts Inst. of Tech., Cambridge, MA,
Rept. No. NASA-CR-158620; LID-R-904, 33 pp (May 1979)
N79-24695

Key Words: Linear systems, Perturbation theory

The cases of both additive and multiplicative perturbations are discussed and a number of relationships between the two cases are given. A number of computational aspects of the theory are also discussed, including a proposed new method for evaluating general transfer or frequency response matrices.

MODELING TECHNIQUES

(Also see Nos. 110, 114, 116, 158)

80-188

The Dynamic Modelling of a Slotted Test Section

G. Gumas

Pennsylvania State Univ., University Park, PA,
Rept. No. NASA-CR-159069, 36 pp (May 1979)
N79-26065

Key Words: Mathematical models, Dynamic structural analysis

A mathematical model of the wind tunnel dynamics is developed. The modeling techniques are restricted to the use of one dimensional unsteady flow. The dynamic characteristics of slotted test section incorporated into the model are presented.

80-189

An Accurate Method of Dynamic Substructuring with Simplified Computation

Y. Leung

Dept. of Civil Engrg., Univ. of Hong Kong, Hong Kong,
Intl. J. Numer. Methods Engr., 14 (8), pp 1241-1256 (1979) 3 figs, 6 tables, 22 refs

Key Words: Substructure modeling

A new dynamic substructuring method is presented. The substructures are identified by their fixed-interface modes and the condensed stiffness and mass matrices at zero vibration frequency. Physical coordinates are used instead of the modal coordinates to make the condition of compatibility between elements applicable. The dimension of the fundamental matrices is equal to the number of interface coordinates for each substructure. All information needed to formulate the fundamental matrices may be obtained experimentally. Both discrete and continuous parameter models are considered.

NONLINEAR ANALYSIS

(Also see No. 205)

80-190

Nonlinear Transient Analysis via Energy Minimization

M.P. Kamat and N.F. Knight, Jr.
Virginia Polytechnic Inst. and State Univ., Blacksburg, VA, AIAA J., 17 (9), pp 968-969 (Sept 1979) 3 figs, 5 refs

Key Words: Nonlinear response, Transient response

For solution two distinct approaches exist: the vector approach and the scalar approach. In the former, a mathematical model is derived on the basis of the principle of virtual work and reduces to a system of nonlinear second-order differential equations in time. In the latter approach, a potential function associated with the energy of the model is introduced, minimization of which yields the desired equilibrium configuration. In both approaches a temporal finite-difference scheme is utilized to effectively eliminate time as a variable. In the scalar approach the problem is then reduced to a well known problem in mathematical programming; namely, the unconstrained minimization of a nonlinear function of several variables.

NUMERICAL METHODS

80-191

Dynamic Response of Axisymmetric Solids Subjected to Impact and Spin

G.R. Johnson
Honeywell, Inc., Hopkins, MN, AIAA J., 17 (9), pp 975-979 (Sept 1979) 7 figs, 1 table, 10 refs

Key Words: Numerical analysis, Bodies of revolution, Impact response (mechanical)

A numerical method is presented to obtain solutions for axisymmetric solids subjected to impact and spin. The method is based on a finite element formulation wherein the equations of motion are integrated directly rather than through the traditional stiffness matrix approach. The formulation is given for axisymmetric triangular elements which can experience large strains and displacements in the radial, axial, and angular directions. The effects of material strength and compressibility are included to account for elastic-plastic flow and wave propagation.

PARAMETER IDENTIFICATION

80-192

Active Control for the Total-in-Flight Simulator (ACTIFS). Final Report

E.G. Rynaski, D. Andrisani, II, and N. Weingarten
Calspan Corp., Buffalo, NY, Rept. No. NASA-CR-3118; AK-5280-F-11, 303 pp (Apr 1979)
N79-23978

Key Words: Parameter identification technique, Aircraft, Mathematical models, Aeroelasticity

An identification procedure is developed to systematically improve or update the mathematical model of the aeroelastic behavior of an airplane. A mathematical model that was originally obtained by analytical or theoretical methods is made amenable to piecemeal acceptance of parameters estimated from the data taken during flight tests. Linear optimal control theory is used to evolve a performance index specifying closed loop system dynamics. Control laws for the proper pole placement of seven modes of motion of the TIFS airplane, two rigid body and five elastic modes, are specified according to criteria developed.

80-193

First Order Formulation of Resonance Testing

J.-G. Beliveau
Dept. of Civil Engrg., Universite de Sherbrooke, Sherbrooke, Quebec, Canada J1K 2R1, J. Sound Vib., 65 (3), pp 319-327 (Aug 8, 1979) 2 figs, 1 table, 10 refs

Key Words: Parameter identification, Frequency response method

An efficient formula for determining the matrix of frequency response functions is derived for the linear system of ordinary differential equations of structural dynamics having constant coefficients. The eigenvalues and eigenvectors of the system associated with the known mass, stiffness and damping matrices are used to accomplish this.

OPTIMIZATION TECHNIQUES

80-194

Optimum Design of Structures with Regard to Their Vibrational Characteristics (5th Report, Minimum Weight Design with Many Constraints in Natural Frequencies)

H. Yamakawa, Y. Fusasaki, and Y. Saito
School of Science and Engrg., Waseda Univ., Shinjuku-ku, Japan, Bull. JSME, 22 (169), pp 919-924 (July 1979) 15 figs, 4 refs

Key Words: Optimization, Minimum weight design, Rods, Beams, Beam-columns

This study is devoted to more complicated optimum design problems in which minimum weight designs with many constraints on natural frequencies are present. Both fundamental and second natural frequencies are constrained.

COMPUTER PROGRAMS

(Also see No. 109)

80-195

SNAP: The SACLANTCEN Normal-Mode Acoustic Propagation Model

F.B. Jensen and M.C. Ferla

Saclant ASW Research Centre La Specia, Italy, Rept. No. SACLANTCEN-SM-121, 109 pp (Jan 15, 1979) AD-A067 256/8GA

Key Words: Sound transmission, Mathematical models, Underwater sound, Computer programs

A sound-propagation model based on normal mode theory is described. The model is designed to give a realistic treatment of the ocean environment, including arbitrary sound-speed profiles in both water column and bottom, compressional and shear wave attenuation, scattering at rough boundaries, and range dependence. Furthermore, the model has a flexible input/output structure that facilitates model handling and provides users with a wide choice of computational (output) options, ranging from plots of sound-speed profiles and individual-mode functions to contoured transmission loss versus depth and range or versus frequency and range. The computer code is written in FORTRAN V with a few routines in NUALGOL. The version documented here runs on a UNIVAC 1106.

80-196

Applicability of General-Purpose Finite Element Programs in Solid-Fluid Interaction Problems

N. Akkas, H.U. Akay, and C. Yilmaz

Dept. of Civil Engrg., Middle East Technical Univ., Ankara, Turkey, Computers Struc., 10 (5), pp 773-783 (Oct 1979) 9 figs, 2 tables, 24 refs

Key Words: Computer programs, Finite element technique, Interaction: structure-fluid

The elasticity matrix of a general-purpose finite element program, SAP IV, is modified in such a way that it becomes possible to idealize water as a structural finite element with zero shear modulus. Using the modified version of SAP IV, several solid-fluid interaction problems are solved. The numerical solutions are compared with the available analytical solutions. They are shown to be in reasonable agreement. Also, by solving an exterior shell-fluid interaction problem, the pressure wave propagation in the acoustic medium is presented. The uses of both the direct-integration and the mode-superposition options of the program are investigated for the time-integration of the interaction problems.

80-197

Kinematic and Dynamic Analysis of Complicated Spatial Mechanisms – Represented at the Example of a Passenger Car – Front Wheel-Guide Mechanism (Kinematische und dynamische Analyse von komplizierten räumliehen Mechanismen - dargestellt am Beispiel eines PKW-Vorderrad-Führungsmechanismus)

G. Kunad, R. Goetze, and J. Nothdurft

Technische Hochschule Magdeburg, Sektion Maschinenbau, Maschinenbautechnik, 28 (6), pp 279-282 (1979) 7 figs, 10 refs
(In German)

Key Words: Computer programs, Automobiles, Control equipment, Mechanisms

The computer program SPAMEC is composed of subprograms which, in addition to the calculation of response of a mechanism to any external excitation, facilitates the solution of specific problems by inserting problem oriented subroutines. The program is illustrated in an analysis of a guide mechanism for a passenger car front wheel.

80-198

A Variable-Step Central Difference Method for Structural Dynamics Analysis. Part 1. Theoretical Aspects. Part II. Implementation and Performance Evaluation

K.C. Park and P.G. Underwood

Palo Alto Research Lab., Lockheed Missiles and

Space Co., Inc., Palo Alto, CA, Rept. No. LMSC/ D626886, LMSC/D633 782, 25 pp (Apr 1979)
AD-A068 598/2GA

Key Words: Computer programs, Damping effects

Part I: Three major theoretical aspects of variable-step explicit integration procedures are proposed and analyzed. These include basic fixed-step integration formulas for no damping, diagonal damping and nondiagonal damping problems; the adjustment of the basic formulas to accommodate step changes; and, step size selection criteria. The apparent frequency concept is introduced to maximize stable step sizes. Part II: The variable-step central difference method developed in Part I is implemented as a stand-alone software package that is easily accessed by existing structural dynamics analyzers (i.e., finite-element, -difference discrete element computer codes) through a common data structure, input/output (I/O) manager and a few user-supplied control and interface routines. The performance of this package is evaluated through a computer study of four sample problems that embody a large class of response characteristics: linear to highly nonlinear; wave to structural to uncoupled component response; narrow to wide frequency spread; no damping to over-damping and accuracy-critical to numerical-stability-critical response.

CONFERENCE PROCEEDINGS AND GENERAL TOPICS

CONFERENCE PROCEEDINGS

80-199

Inter-Noise 78. Design for Noise Control. Proc.
1978 International Conference on Noise Control Engineering, San Francisco, CA, May 8-10, 1978, W.W. Lang, Ed., Noise Control Engineering, P.O. Box 3469, Arlington Branch, Poughkeepsie, NY 12603, 1058 pp, 1978

Key Words: Noise reduction, Industrial facilities, Machinery noise, Transportation noise

In this proceedings volume about 200 authors summarize the state-of-the-art of noise and control technology. In the Distinguished Lectures Series section, papers by eminent research engineers are presented. The section on Special Topics contains papers on Sweden's noise control technology, European noise regulations, and noise from industrial fans. In the section Industrial Noise Control, in addition to this general topic, reduction of machinery noise in plant and exterior industrial noise, is discussed. The section on Community Noise covers outdoor attenuation of noise, community noise effects and control, community response to noise, and building noise control. Papers on measurement of transportation noise, aircraft and airport noise, rail and ship noise, traffic noise prediction and measurement, and traffic noise abatement are in the Traffic Noise section. New techniques, devices and facilities for the solution of noise control problems are presented in the Tools for Noise Control. In an innovative feature, Noise Clinics, solutions to the typical noise control problems are presented.

80-200

Noise Control and Vibration Isolation
Volume 10, Number 6, June/July 1979

Key Words: Reviews, Noise reduction, Vibration control

This issue is the 1979 annual survey issue containing brief descriptions of 157 companies providing acoustical goods and services. The descriptions are listed alphabetically by company and include a reader inquiry card for further information.

80-201

Symposium on the Dynamics of Vehicles on Roads and Tracks
Vehicle Syst. Dyn., 8 (2-3) (Sept 1979)

Key Words: Proceedings, Interaction: rail-wheel, Interaction: wheel-pavement

This special issue contains 38 extensive summaries of papers presented at the 6th International Association for Vehicle System Dynamics Symposium on the Dynamics of Vehicles on Roads and Tracks, Berlin, September 3-7, 1979.

TUTORIALS AND REVIEWS

80-202

Update on the Low Wavenumber Content of TBL Pressure Fields
L.D. Pope

Supervisory Consultant, Bolt Beranek and Newman, Inc., Canoga Park, CA 91303, Shock Vib. Dig., 11 (8), pp 15-18 (Aug 1979) 1 fig, 7 refs

Key Words: Reviews, Turbulence, Experimental data

This review article summarizes results of measurements directed at the low wavenumber component of turbulent boundary layer (TBL) pressure fluctuations for the case of low subsonic flow.

80-203

Nonstationary and Nonlinear Vibration Analysis

B.N. Agrawal and R.M. Evan-Iwanowski

COMSAT Labs., Clarksburg, MD, Shock Vib. Dig., 11 (8), pp 19-22 (Aug 1979) 15 refs

Key Words: Reviews, Testing techniques, Resonant response

This paper is a review of experiments that have been used to verify analyses for combination and internal resonances. Recent work on nonstationary and nonlinear vibrations in multiple-degree-of-freedom systems is also described.

80-204

Recent Developments for the Nonlinear Distortion of Non-Dispersive Acoustic Waves. Part II: Multi-dimensional Systems

J.H. Ginsberg

School of Mech. Engrg., Purdue Univ., West Lafayette, IN 47907, Shock Vib. Dig., 11 (8), pp 3-12 (Aug 1979) 7 figs, 104 refs

Key Words: Reviews, Acoustic waves, Perturbation theory

This two-part paper describes a perturbation procedure for investigating finite amplitude acoustic waves that depend on more than one spatial coordinate. The discussion focuses on wave motions that are non-dispersive in the linear approximation, in which case amplitude dispersion and self-refraction are the primary mechanisms for nonlinear distortion. Part I covered planar waves and the basic method. In Part II the results for a variety of systems are presented, and some types of further research are suggested.

80-205

Techniques and Applications of Mechanical Signature Analysis

R.H. Volin

Shock and Vibration Information Center, Naval Research Lab., Washington, D.C. 23075, Shock Vib. Dig., 11 (9), pp 17-33 (Sept 1979) 2 figs, 98 refs

Key Words: Reviews, Signature analysis, Diagnostic techniques

Mechanical signature analysis is a process of monitoring the vibration signatures of operating machinery systems or their components to determine their condition. It can also be used to diagnose the cause of a fault. The extensive literature on this subject includes the sources of vibration in rotating machinery, instrumentation, measurement techniques, data processing techniques, applications to various types of machinery and systems, and the experiences of users. This paper is a review of mechanical signature analysis. Its use in monitoring the condition of rotating machinery is emphasized because the vibration signature is self generated.

80-206

Damping in Structural Joints

C.F. Beards

Dept. of Mech. Engrg., Imperial College of Science and Tech., London SW7, UK, Shock Vib. Dig., 11 (9), pp 35-41 (Sept 1979) 63 refs

Key Words: Reviews, Structural members, Joints (junctions), Coulomb friction

The frictional damping mechanisms that can occur in structural joints are discussed. Linearized theories appear adequate for describing the macroslip range. Optimum joint clamping forces exist for maximum energy dissipation and for minimum structural response and have been experimentally confirmed.

80-207

A History of Shock Testing of Ships with Underwater Explosions

R.L. Bort

Naval Research Lab., Washington, D.C. 20375, Shock Vib. Dig., 11 (9), pp 9-15 (Sept 1979)

Key Words: Reviews, Ships, Underwater explosions

The author traces the development of shock testing of ships. He describes the testing performed by the British and the Germans during World War II, as well as Operation Crossroads, one of the biggest ship testing operations ever conducted.

CRITERIA, STANDARDS, AND SPECIFICATIONS

(See Nos. 112, 182)

BIBLIOGRAPHIES

80-208

Nondestructive Ultrasonic Testing and Inspection. Volume 5. May, 1977 - May, 1979 (Citations from the NTIS Data Base)

G.E. Habercom, Jr.

National Technical Information Service, Springfield, VA, 228 pp (July 1979)

NTIS/PS-79/0635/7GA

Key Words: Bibliographies, Testing techniques, Testing equipment, Nondestructive tests

Ultrasonic equipment and techniques for nondestructive inspection/testing of materials and fabrication processes are investigated in these Government-sponsored research reports. (This updated bibliography contains 222 abstracts, 98 of which are new entries to the previous edition.)

80-209

Finite Elements in Structural Analysis. Volume 2. July, 1977 - June, 1979 (A Bibliography with Abstracts)

B. Carrigan

National Technical Information Service, Springfield, VA, 163 pp (July 1979)

NTIS/PS-79/0706/6GA

Key Words: Dynamic structural analysis, Finite element technique, Bibliographies

The bibliography cites Government-sponsored research reports concerning finite element analysis as applied to structural mechanics problems. Some computer programs are mentioned. (This updated bibliography contains 154 abstracts, 77 of which are new entries to the previous edition.)

80-210

Structural Mechanics Software. Volume 2. May, 1975 - May, 1979 (A Bibliography with Abstracts)

B. Carrigan

National Technical Information Service, Springfield, VA, 274 pp (June 1979)

NTIS/PS-79-0572/2GA

Key Words: Computer programs, Bibliographies

The use of computer programs in structural analysis-design problems are cited. Detailed analyses are included of structural problems -- applied and theoretical -- including stress analysis, vibration, deformation, etc. The major computer programs cited in this report are NASTRAN, EPSOLA, SUPERSCEPTRE, and SINGER. (This updated bibliography contains 265 abstracts, 51 of which are new entries to the previous edition.)

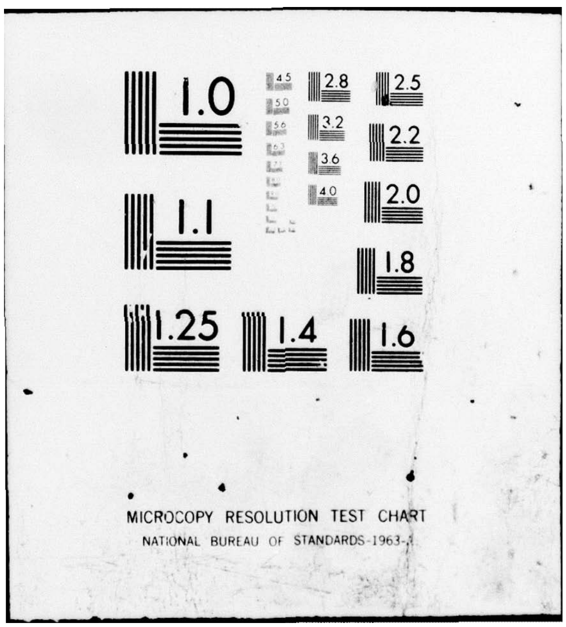
AUTHOR INDEX

AD-A081 171 NAVAL RESEARCH LAB WASHINGTON DC SHOCK AND VIBRATION--ETC F/G 20/11
THE SHOCK AND VIBRATION DIGEST. VOLUME 12, NUMBER 1,(U)
JAN 80 J NAGLE-ESHLEMAN

UNCLASSIFIED NL

2 OF 2
AD
A081171

END
DATE
FILMED
3-80
DDC


1.0
1.1
1.25
1.4
1.6
1.8
2.0
2.2
2.5
2.8
3.2
3.6
4.0
MICROCOPY RESOLUTION TEST CHART
NATIONAL BUREAU OF STANDARDS-1963-A

PERIODICALS SCANNED

PUBLICATION AND ADDRESS	ABBREVIATION
ACTA MECHANICA Springer-Verlag New York, Inc. 175 Fifth Ave. New York, NY 10010	Acta Mech.
ACUSTICA S. Hirzel Verlag, Postfach 347 D-700 Stuttgart 1 W. Germany	Acustica
AERONAUTICAL JOURNAL Royal Aeronautical Society 4 Hamilton Place London W1V 0BQ, UK	Aeronaut. J.
AERONAUTICAL QUARTERLY Royal Aeronautical Society 4 Hamilton Place London W1V 0BQ, UK	Aeronaut. Quart.
AIAA JOURNAL American Institute of Aeronautics and Astronautics 1290 Avenue of the Americas New York, NY 10019	AIAA J.
AMERICAN SOCIETY OF CIVIL ENGINEERS, PROCEEDINGS Publications Office, ASCE United Engineering Center 345 East 47th St. New York, NY 10017	
JOURNAL OF ENERGY DIVISION	ASCE J. Energy Div.
JOURNAL OF ENGINEERING MECHANICS DIVISION	ASCE J. Engr. Mech. Div.
JOURNAL OF ENVIRONMENTAL ENGINEERING DIVISION	ASCE J. Environ. Engr. Div.
JOURNAL OF GEOTECHNICAL ENGINEERING DIVISION	ASCE J. Geotech. Engr. Div.
JOURNAL OF HYDRAULICS DIVISION	ASCE J. Hydraulics Div.
JOURNAL OF IRRIGATION AND DRAINAGE DIVISION	ASCE J. Irrigation Drainage Div.
JOURNAL OF STRUCTURAL DIVISION	ASCE J. Struc. Div.
JOURNAL OF TRANSPORTATION ENGINEERING DIVISION	ASCE J. Transport. Engr. Div.
AMERICAN SOCIETY OF LUBRICATING ENGINEERS, TRANSACTIONS Academic Press 111 Fifth Ave. New York, NY 10019	ASLE, Trans.
AMERICAN SOCIETY OF MECHANICAL ENGINEERS, TRANSACTIONS United Engineering Center 345 East 47th St. New York, NY 10017	
JOURNAL OF APPLIED MECHANICS	J. Appl. Mech., Trans. ASME
JOURNAL OF DYNAMIC SYSTEMS, MEASUREMENT AND CONTROL	J. Dyn. Syst., Meas. and Control, Trans. ASME
JOURNAL OF ENGINEERING FOR INDUSTRY	J. Engr. Indus., Trans. ASME
JOURNAL OF ENGINEERING FOR POWER	J. Engr. Power, Trans. ASME
JOURNAL OF LUBRICATION TECHNOLOGY	J. Lubric. Tech., Trans. ASME
JOURNAL OF MECHANICAL DESIGN	J. Mech. Des., Trans. ASME
JOURNAL OF PRESSURE VESSEL TECHNOLOGY	J. Pressure Vessel Tech., Trans. ASME
APPLIED ACOUSTICS Applied Science Publishers, Ltd. Ripple Road, Barking Essex, UK	Appl. Acoust.
APPLIED MATHEMATICAL MODELING IPC House 32 High St., Guildford Surrey GU1 3EW, UK	Appl. Math. Modeling
ARCHIVES OF ACOUSTICS Polish Academy of Sciences Committee on Acoustics Polish Acoustical Society	Arch. Acoust.
ARCHIVES OF MECHANICS (ARCHIWUM MECHANIKI STOSOWANEJ) Export and Import Enterprise Ruch UL, Wronia 23, Warsaw, Poland	Arch. Mech.
ASTRONAUTICS AND AERONAUTICS AIAA EDP 1290 Avenue of the Americas New York, NY 10019	Astronaut. & Aeronaut.
AUTOMOBILTECHNISCHE ZEITSCHRIFT Franckh'sche Verlagshandlung Abteilung Technik 7000 Stuttgart 1 Pfizerstrasse 5-7 W. Germany	Automobiltech. Z.

PUBLICATION AND ADDRESS	ABBREVIATION
AUTOMOTIVE ENGINEER (SAE) Society of Automotive Engineers, Inc. 400 Commonwealth Drive Warrendale, PA 15096	Auto. Engr. (SAE)
AUTOMOTIVE ENGINEER (UK) P.O. Box 24, Northgate Ave. Bury St., Edmunds Suffolk IP21 GBW, UK	Auto. Engr. (UK)
BALL BEARING JOURNAL (English Edition) SKF (U.K.) Ltd. Luton, Bedfordshire LU3 1JF, UK	Ball Bearing J.
BROWN BOVERI REVIEW Brown Boveri and Co., Ltd. CH-5401, Baden, Switzerland	Brown Boveri Rev.
BULLETIN DE L'ACADEMIE POLONAISE DES SCIENCES, SERIES DES SCIENCES TECHNIQUES Ars Polona-Ruch 7 Krokowskie Przedmiescie, Poland	Bull. Acad. Polon. Sci., Ser. Sci. Tech.
BULLETIN OF JAPAN SOCIETY OF MECHANICAL ENGINEERS Japan Society of Mechanical Engineers Sanshin Hokusei Bldg. H-9 Yoyogi 2-chome Shibuya-ku Tokyo 151, Japan	Bull. JSME
BULLETIN OF SEISMOLOGICAL SOCIETY OF AMERICA Bruce A. Bolt Box 826 Berkeley, CA 94705	Bull. Seismol. Soc. Amer.
CIVIL ENGINEERING (NEW YORK) ASCE Publications Office 345 E. 47th St. New York, NY 10017	Civ. Engr. (N.Y.)
COMPUTERS AND STRUCTURES Pergamon Press Inc. Maxwell House, Fairview Park Elmsford, NY 10523	Computers Struc.
DESIGN NEWS Cahners Publishing Co., Inc. 221 Columbus Ave. Boston, MA 02116	Des. News
DIESEL AND GAS TURBINE PROGRESS Diesel Engines, Inc. P.O. Box 7406 Milwaukee, WI 53213	Diesel Gas Turbine Prog.
ENGINEERING MATERIALS AND DESIGN IPC Industrial Press Ltd. 33-40 Bowling Green Lane London EC1R, UK	Engr. Matl. Des.
EXPERIMENTAL MECHANICS Society for Experimental Stress Analysis 21 Bridge Sq., P.O. Box 277 Westport, CT 06880	Exptl. Mech.
FORSCHUNG IM INGENIEURWESEN Verein Deutscher Ingenieur, GmbH Postfach 1139 Graf-Recke Str. 84 4 Düsseldorf 1 W. Germany	Forsch. Ingenieurw.
HEATING/PIPING/AIR CONDITIONING Circulation Dept. 614 Superior Ave. West Cleveland, OH 44113	Heating/ Piping/ Air Cond.
HYDRAULICS AND PNEUMATICS Penton/IPC, Inc. 614 Superior Ave., West Cleveland, OH 44113	Hydraulics & Pneumatics
HYDROCARBON PROCESSING Gulf Publishing Co. Box 2608 Houston, TX 77001	Hydrocarbon Processing
IBM JOURNAL OF RESEARCH AND DEVELOPMENT International Business Machines Corp. Armonk, NY 10504	IBM J. Res. Dev.
INDUSTRIAL RESEARCH Dun-Donnelley Publishing Corp. 222 S. Riverside Plaza Chicago, IL 60606	Indus. Res.
INGENIEUR-ARCHIV Springer-Verlag New York, Inc. 175 Fifth Ave. New York, NY 10010	Ing. Arch.
INSTITUTE OF MARINE ENGINEERS, TECHNICAL REPORTS The Memorial Building 76 Mark Lane London EC3R 7IN, UK	Inst. Mar. Engr., T.R.
INSTITUTION OF ENGINEERS, AUSTRALIA, CIVIL ENGINEERING TRANSACTIONS 11 National Circuit Barton, A.C.T. 2600, Australia	Instn. Engr., Austral., C.E. Trans.
INSTITUTION OF ENGINEERS, AUSTRALIA, ELECTRICAL ENGINEERING TRANSACTIONS 11 National Circuit Barton, A.C.T. 2600, Australia	Instn. Engr., Austral., E.E. Trans.
INSTITUTION OF MECHANICAL ENGINEERS, (LONDON), PROCEEDINGS Institution of Mechanical Engineers 1 Birdcage Walk, Westminster, London SW1, UK	Instn. Mech. Engr. Proc.
INSTRUMENT SOCIETY OF AMERICA, TRANSACTIONS Instrument Society of America 400 Stanwix St. Pittsburgh, PA 15222	ISA Trans.
INTERNATIONAL JOURNAL OF CONTROL Taylor and Francis Ltd. 10-14 Macklin St. London WC2B 5NF, UK	Intl. J. Control
INTERNATIONAL JOURNAL OF EARTHQUAKE ENGINEERING AND STRUCTURAL DYNAMICS John Wiley and Sons, Ltd. 650 Third Ave. New York, NY 10016	Intl. J. Earthquake Engr. Struc. Dynam.

PUBLICATION AND ADDRESS	ABBREVIATION
INTERNATIONAL JOURNAL OF ENGINEERING SCIENCES Pergamon Press Inc. Maxwell House, Fairview Park Elmsford, NY 10523	Intl. J. Engr. Sci.
INTERNATIONAL JOURNAL OF FATIGUE IPI Science and Technology Press Ltd. 32 High St., Guildford Surrey GU1 3EW, UK	Intl. J. Fatigue
INTERNATIONAL JOURNAL OF MACHINE TOOL DESIGN AND RESEARCH Pergamon Press, Inc. Maxwell House, Fairview Park Elmsford, NY 10523	Intl. J. Mach. Tool Des. Res.
INTERNATIONAL JOURNAL OF MECHANICAL SCIENCES Pergamon Press, Inc. Maxwell House, Fairview Park Elmsford, NY 10523	Intl. J. Mech. Sci.
INTERNATIONAL JOURNAL OF NONLINEAR MECHANICS Pergamon Press, Inc. Maxwell House, Fairview Park Elmsford, NY 10523	Intl. J. Nonlin. Mech.
INTERNATIONAL JOURNAL FOR NUMERICAL METHODS IN ENGINEERING John Wiley and Sons, Ltd. 605 Third Ave. New York, NY 10016	Intl. J. Numer. Methods Engr.
INTERNATIONAL JOURNAL FOR NUMERICAL AND ANALYTICAL METHODS IN GEOMECHANICS John Wiley and Sons, Ltd. Baffins Lane Chichester, Sussex, UK	Intl. J. Numer. Anal. Methods Geomech.
INTERNATIONAL JOURNAL OF SOLIDS AND STRUCTURES Pergamon Press, Inc. Maxwell House, Fairview Park Elmsford, NY 10523	Intl. J. Solids Struc.
INTERNATIONAL JOURNAL OF VEHICLE DESIGN The International Assoc. of Vehicle Design The Open University, Walton Hall Milton Keys MK7 6AA, UK	Intl. J. Vehicle Des.
ISRAEL JOURNAL OF TECHNOLOGY Weizmann Science Press of Israel Box 801 Jerusalem, Israel	Israel J. Tech.
JOURNAL OF THE ACOUSTICAL SOCIETY OF AMERICA American Institute of Physics 335 E. 45th St. New York, NY 10010	J. Acoust. Soc. Amer.
JOURNAL OF AIRCRAFT American Institute of Aeronautics and Astronautics 1290 Avenue of the Americas New York, NY 10019	J. Aircraft
JOURNAL OF THE AMERICAN HELICOPTER SOCIETY American Helicopter Society, Inc. 30 E. 42nd St. New York, NY 10017	J. Amer. Helicopter Soc.
JOURNAL OF ENGINEERING MATHEMATICS Academic Press 198 Ash Street Reading, MA 01867	J. Engr. Math.
JOURNAL OF ENVIRONMENTAL SCIENCES Institute of Environmental Sciences 940 E. Northwest Highway Mt. Prospect, IL 60056	J. Environ. Sci.
JOURNAL OF FLUID MECHANICS Cambridge University Press 32 East 57th St. New York, NY 10022	J. Fluid Mech.
JOURNAL OF THE FRANKLIN INSTITUTE Pergamon Press, Inc. Maxwell House, Fairview Park Elmsford, NY 10523	J. Franklin Inst.
JOURNAL OF HYDRONAUTICS American Institute of Aeronautics and Astronautics 1290 Avenue of the Americas New York, NY 10019	J. Hydronautics
JOURNAL OF THE INSTITUTE OF ENGINEERS, AUSTRALIA Science House, 157 Gloucter Sydney, Australia 2000	J. Inst. Engr., Austral.
JOURNAL OF MECHANICAL ENGINEERING SCIENCE Institution of Mechanical Engineers 1 Birdcage Walk, Westminster London SW1 H9, UK	J. Mech. Engr. Sci.
JOURNAL OF THE MECHANICS AND PHYSICS OF SOLIDS Pergamon Press, Inc. Maxwell House, Fairview Park Elmsford, NY 10523	J. Mech. Phys. Solids
JOURNAL OF PHYSICS E. (SCIENTIFIC INSTRUMENTS) American Institute of Physics 335 East 45th St. New York, NY 10017	J. Phys. E. (Sci. Instr.)
JOURNAL OF SHIP RESEARCH Society of Naval Architects and Marine Engineers 20th and Northhampton Sts. Easton, PA 18042	J. Ship Res.
JOURNAL OF SOUND AND VIBRATION Academic Press 111 Fifth Ave. New York, NY 10019	J. Sound Vib.

PUBLICATION AND ADDRESS	ABBREVIATION
JOURNAL OF SPACECRAFT AND ROCKETS American Institute of Aeronautics and Astronautics 1290 Avenue of the Americas New York, NY 10019	J. Space-craft Rockets
JOURNAL OF TESTING AND EVALUATION (ASTM) American Society for Testing and Materials 1916 Race St. Philadelphia, PA 19103	J. Test Eval. (ASTM)
KONSTRUKTION Spring Verlag 3133 Connecticut Ave., N.W. Suite 712 Washington, D.C. 20008	Konstruktion
LUBRICATION ENGINEERING American Society of Lubrication Engineers 838 Busse Highway Park Ridge, IL 60068	Lubric. Engr.
MACHINE DESIGN Penton Publishing Co. Penton Bldg. Cleveland, OH 44113	Mach. Des.
MASCHINENBAUTECHNIK VEB Verlag Technik Oranienburger Str. 13/14 102 Berlin, E. Germany	Maschinen-bautechnik
MECCANICA Pergamon Press, Inc. Maxwell House, Fairview Park Elmsford, NY 10523	Meccanica
MECHANICAL ENGINEERING American Society of Mechanical Engineers 345 E. 45th St. New York, NY 10017	Mech. Engr.
MECHANICS RESEARCH AND COMMUNICATIONS Pergamon Press, Inc. Maxwell House, Fairview Park Elmsford, NY 10523	Mech. Res. Comm.
MECHANISM AND MACHINE THEORY Pergamon Press, Inc. Maxwell House, Fairview Park Elmsford, NY 10523	Mech. Mach. Theory
MEMOIRES OF THE FACULTY OF ENGINEERING, KYOTO UNIVERSITY Kyoto University Kyoto, Japan	Mem. Fac. Engr. Kyoto Univ.
MTZ MOTORTECHNISCHE ZEITSCHRIFT Franskh'sche Verlagshandlung Pfizerstrasse 5-7 7000 Stuttgart 1 W. Germany	MTZ Motor-tech. Z.
NAVAL ENGINEERS JOURNAL American Society of Naval Engineers, Inc. Suite 507, Continental Bldg. 1012 - 14th St., N.W. Washington, D.C. 20005	Naval Engr. J.

PUBLICATION AND ADDRESS	ABBREVIATION
NOISE CONTROL VIBRATION ISOLATION Trade and Technical Press Ltd. Crown House, Morden Surrey SM4 5EW, UK	Noise Control Vib. Isolation
NOISE CONTROL ENGINEERING P.O. Box 3206, Arlington Branch Poughkeepsie, NY 12603	Noise Control Engr.
NORTHEAST COAST INSTITUTION OF ENGINEERS AND SHIPBUILDERS, TRANSACTIONS Bolbec Hall Newcastle upon Tyne 1, UK	NE Coast Instn. Engrs. Shipbldrs., Trans.
NUCLEAR ENGINEERING AND DESIGN North Holland Publishing Co. P.O. Box 3489 Amsterdam, The Netherlands	Nucl. Engr. Des.
OIL AND GAS JOURNAL The Petroleum Publishing Co. 211 S. Cheyenne Tulsa, OK 74101	Oil Gas J.
PACKAGE ENGINEERING 5 S. Wabash Ave. Chicago, IL 60603	Package Engr.
PLANT ENGINEERING 1301 S. Grove Avenue Barrington, IL 60010	Plant Engr.
POWER P.O. Box 521 Hightston, NJ 08520	Power
POWER TRANSMISSION DESIGN Industrial Publishing Co. Division of Pittway Corp. 812 Huron Rd. Cleveland, OH 44113	Power Transm. Des.
PRODUCT ENGINEERING (NEW YORK) McGraw-Hill Book Co. P.O. Box 1622 New York, NY	Product Engr. (NY)
QUARTERLY JOURNAL OF MECHANICS AND APPLIED MATHEMATICS Wm. Dawson & Sons, Ltd. Cannon House Folkestone, Kent, UK	Quart. J. Mech. Appl. Math.
REVUE ROUMAINE DES SCIENCES TECHNIQUES, SERIE DE MÉCANIQUE APPLIQUEE Editions De L'Academie De La Republique Socialiste de Roumaine 3 Bis Str., Gutenberg, Bucurest, Romania	Rev. Roumaine Sci. Tech., Mecanique
REVIEW OF SCIENTIFIC INSTRUMENTS American Institute of Physics 335 East 45th St. New York, NY 10017	Rev. Scientific Instr.
SAE PREPRINTS Society of Automotive Engineers Two Pennsylvania Plaza New York, NY 10001	SAE Prepr.

PUBLICATION AND ADDRESS	ABBREVIATION
SIAM JOURNAL ON APPLIED MATHEMATICS Society for Industrial and Applied Mathematics 33 S. 17th St. Philadelphia, PA 19103	SIAM J. Appl. Math.
SIAM JOURNAL ON NUMERICAL ANALYSIS Society for Industrial and Applied Mathematics 33 S. 17th St. Philadelphia, PA 19103	SIAM J. Numer. Anal.
S/V, SOUND AND VIBRATION Acoustic Publications, Inc. 27101 E. Oviat Rd. Bay Village, OH 44140	S/V, Sound Vib.
TECHNISCHES MESSEN - ATM R. Oldenburg Verlag GmbH Rosenheimer Str. 145 8 Munchen 80, W. Germany	Techn. Messen-ATM
TURBOMACHINERY INTERNATIONAL Turbomachinery Publications, Inc. 22 South Smith St. Norwalk, CT 06855	Turbomach. Intl.
VDI ZEITSCHRIFT Verein Deutscher Ingenieur GmbH Postfach 1139, Graf-Recke Str. 84 4 Düsseldorf 1, Germany	VDI Z.
VDI FORSCHUNGSHEFT Verein Deutscher Ingenieur GmbH Postfach 1139, Graf-Recke Str. 84 4 Düsseldorf 1, Germany	VDI Forsch.
VEHICLE SYSTEMS DYNAMICS Swets and Zeitlinger N.V. 347 B. Herreweg Lisse, The Netherlands	Vehicle Syst. Dyn.
WAVE MOTION North Holland Publishing Co. P.O. Box 211 1000 AE Amsterdam The Netherlands	Wave Motion
WEAR Elsevier Sequoia S.A. P.O. Box 851 1001 Lausanne 1, Switzerland	Wear
ZEITSCHRIFT FÜR ANGEWANDTE MATHEMATIK UND MECHANIK Akademie Verlag GmbH Liepziger Str. 3-4 108 Berlin, Germany	Z. angew. Math. Mech.
ZEITSCHRIFT FÜR FLUGWISSENSCHAFTEN DFVLR D-3300 Braunschweig Flughafen, Postfach 3267 W. Germany	Z. Flugwiss

SECONDARY PUBLICATIONS SCANNED

GOVERNMENT REPORTS ANNOUNCEMENTS & INDEX NTIS U.S. Dept. of Commerce Springfield, VA 22161	GRA
SCIENTIFIC AND TECHNICAL AEROSPACE REPORTS Superintendent of Documents U.S. Government Printing Office Washington, D.C. 20402	STAR
DISSERTATION ABSTRACTS INTERNATIONAL University Microfilms Ann Arbor, MI 48106	DA

ANNUAL PROCEEDINGS SCANNED

INSTITUTE OF ENVIRONMENTAL SCIENCES, ANNUAL PROCEEDINGS Institute of Environmental Sciences 940 E. Northwest Highway Mt. Prospect, IL 60056	Inst. Environ.
INTERNATIONAL CONGRESS ON ACOUSTICS, ANNUAL PROCEEDINGS	Intl. Cong. Acoust., Proc.
THE SHOCK AND VIBRATION BULLETIN, UNITED STATES NAVAL RESEARCH LABORATORIES, ANNUAL PROCEEDINGS Shock and Vibration Information Center Naval Research Lab., Code 8404 Washington, D.C. 20375	Shock Vib. Bull., U.S. Naval Res. Lab., Proc.

CALENDAR

JANUARY 1980

22-24 **Reliability & Maintainability Symposium,** San Francisco, CA *(ASME Hq.)*

FEBRUARY 1980

3-7 **Energy Technology Conference and Exhibition** [ASME] New Orleans, LA *(ASME Hq.)*

19 **Current Techniques in Vibration Measurement and Recording** [SEE] London, England *(SEE Hq.)*

26-29 **Congress & Exposition** [SAE] Cobo Hall, Detroit, MI *(SAE Meeting Dept.)*

MARCH 1980

9-13 **25th Annual International Gas Turbine Conference and Exhibit** [ASME] New Orleans, LA *(ASME Hq.)*

24-27 **Design Engineering Conference and Show** [ASME] McCormick Place, Chicago, IL *(ASME Hq.)*

APRIL 1980

21-25 **Acoustical Society of America, Spring Meeting** [ASA] Atlanta, GA *(ASA Hq.)*

28-May 1 **NOISEXPO '80** [S/V, Sound and Vibration] Hyatt Regency O'Hare, Chicago, IL *(Acoustic Publications, Inc., 27101 E. Oviat Rd., Bay Village, OH 44140)*

MAY 1980

5-8 **Offshore Technology Conference,** Astrohall, Houston, TX *(ASME Hq.)*

11-14 **1980 Annual Technical Meeting & Equipment Exposition** [IES] Philadelphia, PA *(IES Hq.)*

19-23 **Fourth International Conference on Pressure Vessel Technology** [ASME] London, England *(ASME Hq.)*

25-30 **Fourth SESA International Congress on Experimental Mechanics** [SESA] The Copley Plaza, Boston, MA *(SESA Hq.)*

JUNE 1980

11 **Experimental Techniques for Fatigue Crack Growth Measurement** [SEE] British Rail Technical Centre *(SEE Hq.)*

22-26 **Summer Annual Meeting** [ASME] Waldorf-Astoria, New York, NY *(ASME Hq.)*

JULY 1980

7-11 **Recent Advances in Structural Dynamics Symp.,** [Institute of Sound and Vibration Research] University of Southampton, Southampton, S09 5NH, UK *(Mrs. O.G. Hyde, ISVR Conference Secretary, The University, Southampton, S09 5NH, UK - Tel (0703) 559122, Ext 2310)*

SEPTEMBER 1980

2-4 **International Conference on Vibrations in Rotating Machinery** [IMechE] Cambridge, England *(Mr. A.J. Tugwell, Institution of Mechanical Engineers, 1 Birdcage Walk, London SW1H 9JJ, UK)*

8-11 **Off-Highway Meeting and Exposition** [SAE] MECCA, Milwaukee, WI *(SAE Hq.)*

OCTOBER 1980

Joint Lubrication Conference [ASME] Washington, D.C. *(ASME Hq.)*

6-8 **Computational Methods in Nonlinear Structural and Solid Mechanics** [George Washington University & NASA Langley Research Center] Washington, D.C. *(Professor A.K. Noor, The George Washington University, NASA Langley Research Center, MS246, Hampton, VA 23665- Tel (804)827-2897)*

NOVEMBER 1980

18-21 **Acoustical Society of America, Fall Meeting** [ASA] Los Angeles, CA *(ASA Hq.)*

DECEMBER 1980

8-10 **INTER-NOISE 80** [International Institute of Noise Control Engineering] Miami, FL *(NTER-NOISE 80, P.O. Box 3469, Arlington Branch, Poughkeepsie, NY 12603)*

CALENDAR ACRONYM DEFINITIONS AND ADDRESSES OF SOCIETY HEADQUARTERS

AFIPS: American Federation of Information Processing Societies
210 Summit Ave., Montvale, NJ 07645

AGMA: American Gear Manufacturers Association
1330 Mass. Ave., N.W.
Washington, D.C.

AHS: American Helicopter Society
1325 18 St. N.W.
Washington, D.C. 20036

AIAA: American Institute of Aeronautics and Astronautics, 1290 Sixth Ave.
New York, NY 10019

AIChE: American Institute of Chemical Engineers
345 E. 47th St.
New York, NY 10017

AREA: American Railway Engineering Association
59 E. Van Buren St.
Chicago, IL 60605

ARPA: Advanced Research Projects Agency

ASA: Acoustical Society of America
335 E. 45th St.
New York, NY 10017

ASCE: American Society of Civil Engineers
345 E. 45th St.
New York, NY 10017

ASME: American Society of Mechanical Engineers
345 E. 45th St.
New York, NY 10017

ASNT: American Society for Nondestructive Testing
914 Chicago Ave.
Evanston, IL 60202

ASQC: American Society for Quality Control
161 W. Wisconsin Ave.
Milwaukee, WI 53203

ASTM: American Society for Testing and Materials
1916 Race St.
Philadelphia, PA 19103

CCCAM: Chairman, c/o Dept. ME, Univ. Toronto,
Toronto 5, Ontario, Canada

ICF: International Congress on Fracture
Tohoku Univ.
Sendai, Japan

IEEE: Institute of Electrical and Electronics Engineers
345 E. 47th St.
New York, NY 10017

IES: Institute of Environmental Sciences
940 E. Northwest Highway
Mt. Prospect, IL 60056

IFToMM: International Federation for Theory of Machines and Mechanisms
U.S. Council for TMM
c/o Univ. Mass., Dept. ME
Amherst, MA 01002

INCE: Institute of Noise Control Engineering
P.O. Box 3206, Arlington Branch
Poughkeepsie, NY 12603

ISA: Instrument Society of America
400 Stanwix St.
Pittsburgh, PA 15222

ONR: Office of Naval Research
Code 40084, Dept. Navy
Arlington, VA 22217

SAE: Society of Automotive Engineers
400 Commonwealth Drive
Warrendale, PA 15096

SEE: Society of Environmental Engineers
6 Conduit St.
London W1R 9TG, UK

SESA: Society for Experimental Stress Analysis
21 Bridge Sq.
Westport, CT 06880

SNAME: Society of Naval Architects and Marine Engineers
74 Trinity Pl.
New York, NY 10006

SPE: Society of Petroleum Engineers
6200 N. Central Expressway
Dallas, TX 75206

SVIC: Shock and Vibration Information Center
Naval Research Lab., Code 8404
Washington, D.C. 20375

URSI-USNC: International Union of Radio Science - U.S. National Committee
c/o MIT Lincoln Lab.
Lexington, MA 02173

PUBLICATIONS AVAILABLE FROM
THE SHOCK AND VIBRATION INFORMATION CENTER
CODE 5804, Naval Research Laboratory, Washington, D.C. 20375

	PRICES Effective - 1 Nov. 1979 U.S.	FOREIGN
SHOCK AND VIBRATION DIGEST		
SVD-12 (Jan. - Dec. 1980)	$100.00	$125.00
SHOCK AND VIBRATION BULLETINS		
SVB-47	$ 15.00	$ 18.75
SVB-48	30.00	37.50
SVB-49	60.00	75.00
SVB-50	100.00	125.00
SHOCK AND VIBRATION MONOGRAPHS		
SVM-2, Theory and Practice of Cushion Design	$ 10.00	$ 12.50
SVM-4, Dynamics of Rotating Shafts	10.00	12.50
SVM-5, Principles and Techniques of Shock Data Analysis	5.00	6.25
SVM-6, Optimum Shock and Vibration Isolation	5.00	6.25
SVM-7, Influence of Damping in Vibration Isolation	15.00	18.75
SVM-8, Selection and Performance of Vibration Tests	10.00	12.50
SVM-9, Equivalence Techniques for Vibration Testing	10.00	12.50
SVM-10, Shock and Vibration Computer Programs	10.00	12.50
SVM-11, Calibration of Shock and Vibration Measuring Transducers	25.00	31.25
SPECIAL PUBLICATION		
An International Survey of Shock and Vibration Technology	60.00	75.00

To order any publication, simply check the line corresponding to that publication that appears below, and mail the postage free card. You will be invoiced at the time of shipment.

Please send the following publication(s) to me:

____
Name

____
Address

____

Mail invoice to: (if other than above)

____

____

____

_____ SVD-12 _____ SVM-5
_____ SVB-47 _____ SVM-6
_____ SVB-48 _____ SVM-7
_____ SVB-49 _____ SVM-8
_____ SVB-50 _____ SVM-9
_____ SVM-2 _____ SVM-10
_____ SVM-4 _____ SVM-11
_____ International Survey

NOW AVAILABLE

A New Shock and Vibration Monograph

CALIBRATION OF SHOCK AND VIBRATION MEASURING TRANSDUCERS

by

Raymond R. Bouche

Price - $25.00 (31.25 Foreign)

This book is intended for shock and vibration engineers concerned with instrument calibration. Calibration procedures, performance characteristics of transducers and measurement techniques are treated.

The monograph should be a welcome addition to the library of any facility where transducers are used to make shock and vibration measurements. It contains a detailed discussion of the theory of seismic transducers, the characteristics of real transducers, absolute calibration methods, the reciprocity calibration method, standard transducers, comparison calibration methods and shock motion calibration methods. To order, mark SVM-11 on the postage-free card.

DEPARTMENT OF THE NAVY

NAVAL RESEARCH LABORATORY, CODE 5804
SHOCK AND VIBRATION INFORMATION CENTER
Washington, D.C. 20375

OFFICIAL BUSINESS
PENALTY FOR PRIVATE USE, $300

POSTAGE AND FEES PAID
DEPARTMENT OF THE NAVY
DOD-316

U.S.MAIL

The Shock and Vibration Information Center
Naval Research Laboratory
Code 5804
Washington, D.C. 20375

ANNUAL SUBSCRIPTION SERVICE PACKAGE FROM THE SHOCK AND VIBRATION INFORMATION CENTER (SVIC)

Basic Package Rate: $500. per year (on a fiscal year basis – 1 October to 30 September)

Note: Annual rate may be increased in multiples of $500 based upon organizational size or requirements.

The Basic Package Contains:	Individual Price
– One subscription to the Shock and Vibration Digest, a monthly current awareness journal containing abstracts from the current literature, systematic literature reviews, informative feature articles, and many other useful features.	$100 per year
– One copy of each SVIC State-of-the-Art Monograph as issued (average one per year).	$20–$40 per copy
– One copy of each SVIC Special Publication issued, such as 1979 International Survey, (free on request to FY 80 subscribers).	$60 per copy
– Up to two registrations at the annual Shock and Vibration Symposium	$100 per registrant
– One set of the Shock and Vibration Bulletin (3–5 volumes of technical papers).	$100 per set
– Up to five hours SVIC staff time for information consultation, search, and analysis.	$250.00

Timely availability of newly generated technical information is a valuable resource. The cost is small. The return is great. Let SVIC serve your information needs in the shock and vibration area.